POWER

Vol. 47 NEW YORK, JUNE 18, 1918 No. 25

Confidence in Employers

IT is the confidence which even the humblest worker has in his employers and the product he helps to make that goes toward general success. Too often we see and hear of engineers and others in power-plant work who lack confidence in their employers.

For instance, an engineer wants some new appliance, a new piece of apparatus or some supplies. He wants them immediately whether they are of great necessity or not. Well, perhaps owing to expenditures in other lines or departments, the firm is not in a position to buy these things just at the time the engineer wants them.

As a result, the engineer loses confidence in his employers—not that the loss of confidence is deserved, for generally the engineer views only one side and that is his. He finally decides that the firm is too cheap to lay out a few dollars, so what is the use of trying to do things. He neglects what old apparatus he has—to his own undoing.

An engineer had a cold-water pump in his plant, drawing water from a deep well and pumping to a high pressure. The pump was not placed in a very suitable position—it was exposed to all sorts of dirt and grit. Of course it was running under hard service, and with a little extra care could have been made to hold out awhile longer. Instead, the engineer wanted a new pump and a larger one. He could not get one, so he made up his mind that the firm was too cheap a firm for him to work for, and he quit. The new engineer came and gave a lot of time and patience to the old pump, and it was not very long before he had a nice increase in salary, besides getting just the pump he wanted.

Engineers, realize that there are other expenses in an isolated plant besides the power house, and your employer has to meet them all. Let your employers see that you have full confidence in what they are doing, and they will surely place confidence in you.

Contributed by J. C. Halvey, Cooperstown, N. Y.

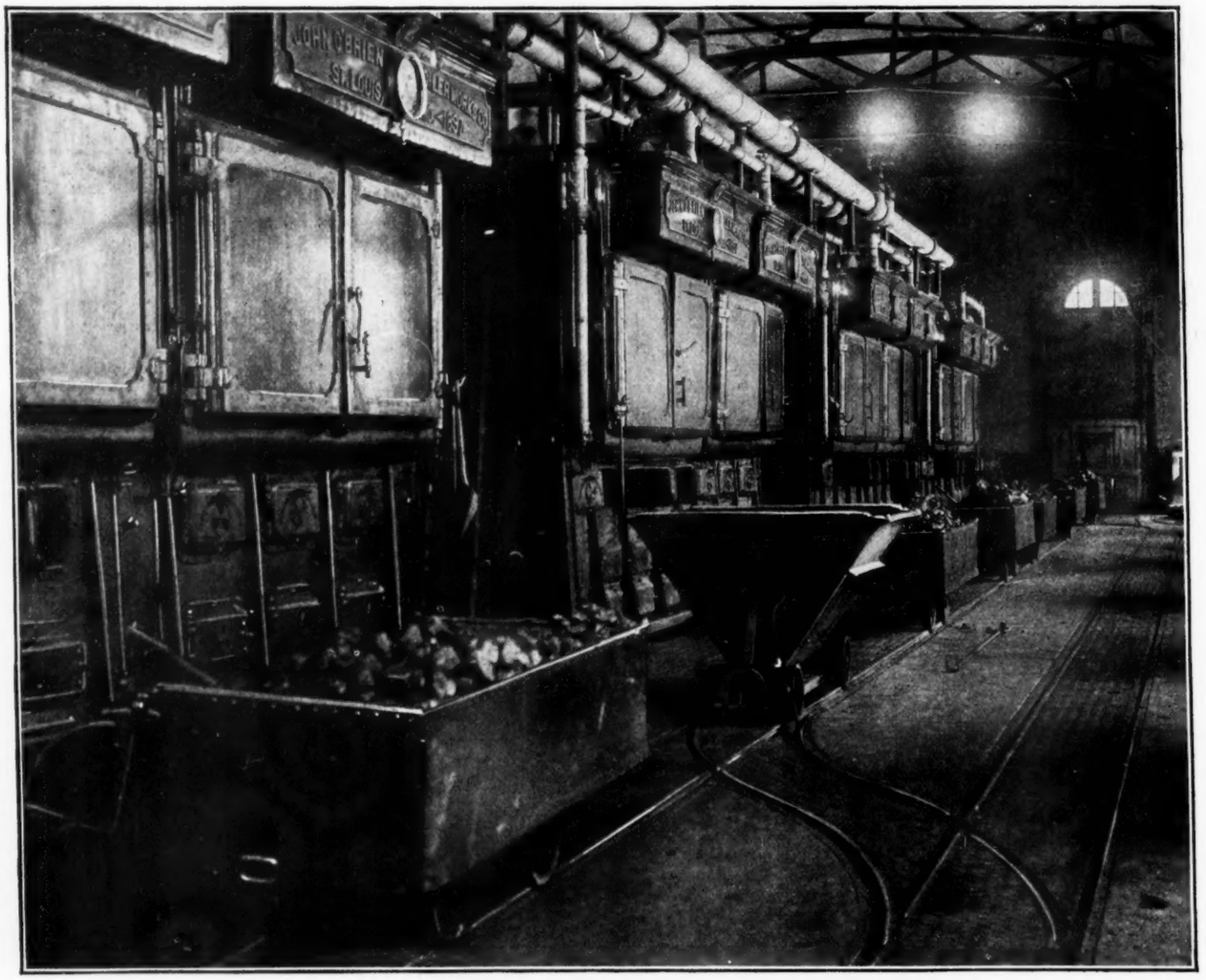


FIG. 1. INTERIOR VIEW OF THE PRESENT BADEN STATION BOILER ROOM

Remodeling the St. Louis Baden Station

BY K. TOENSFELDT

The remodeled station will contain four boilers from an old station and four new boilers of the same type and size, making a total of 3300 boiler horsepower. Chain-grate stokers will be used. The total investment will be $177,500, and it is estimated that the yearly saving in operating expenses will be about $11,797.

THE Baden Station or High-Service Station No. 3 is situated in the northernmost part of the City of St. Louis and was built in 1896. The growth of the city westward, leading farther from the original pumping station and into the higher parts of the surrounding country, necessitated additional pumping capacity and a higher main pressure. The Baden Station, the water mains from which in general circumscribe the older central or downtown parts of the city and supply the outlying western, southern and the higher districts, pumps a pressure of 125 lb. into a closed system. The high-service stations Nos. 1 and 2, supply the central and lower districts and pump against a pressure of 85 pounds.

The high-service stations Nos. 1 and 2, and the low-service station No. 2 have been reconstructed with modern equipment and were completed during the summer of 1916, and in the fall of last year an ordinance was passed appropriating funds for the reconstruction of the Baden Station. Although the present time is most inopportune for such an undertaking, the physical condition of the plant is such that the change is a necessary one. Fortunately, the Water Division is able to make use of much of the equipment from another station where the equipment of two engine houses was connected to the boilers of one remodeled boiler room, leaving the machinery of the abandoned boiler room available.

In the engine room there is little to be done. The six original vertical, triple-expansion pumps are in good condition, some revealing better duties on recent tests than were obtained on the acceptance tests. The re-

modeling of the engine room will merely involve the installation of a single new 10-in. steam header and loop to replace the present three 10-in. mains. The renewal of these is necessitated by the anticipation of using higher steam temperatures, which mean the use of heavier cast-steel valves and fittings in place of the present light cast-iron ones.

There will be a resultant saving in the engine room due to the use of superheated steam in the pumps and a saving in radiation loss due to the single header replacing the three present headers. A series of tests were made on pump No. 13 at the high-service station No. 2 to determine the saving effected by superheating. Fig. 3 shows the results graphically.

It is of interest to mention that superheated steam has caused cracks of destructive extent in the old unannealed high-pressure cylinder heads of the pumping engines at the high-service station No. 1. These were renewed with new annealed heads with properly proportioned reinforcing ribs.

the boiler plant, based on the actual operating and coal costs for the year 1916-17:

Total coal burned, tons	22,750
Cost of egg coal unloaded at $1.65 per ton	$37,537
16 firemen at $90 per month	17,280
16 coal passers at $55 per month	12,480
1 boiler-room foreman at $75 per month	900
1 boiler washer at $90 per month	1,080
Total	$69,277
Cost per 10,000 lb. of steam	$0.24
Total water evaporated, lb	288,000,000
Cost of proposed new tunnel	$10,000
Cost of proposed new bunker, coal and ash-handling equipment	60,000
Cost of four new 400-hp. boilers	35,200
Cost of four new superheaters	7,500
Cost of moving four 400-hp. boilers from Bissell's Point to Baden	3,200
Cost of brick settings for eight boilers	9,600
Cost of stokers for eight boilers	16,000
Changes in steam headers and feed lines	3,000
Cost of new breeching	5,000
Cost of proposed new stack	28,000
Total investment	$177,500

To evaporate 288,000,000 lb. of water with screenings containing 10,000 B.t.u. per lb. would require

$$\frac{288{,}000{,}000 \times 970 \times 1.07}{10{,}000 \times 0.65} = 46{,}000{,}000\ lb.$$

where 1.07 = factor of evaporation and 0.65 = efficiency. Hence with the new equipment we would have

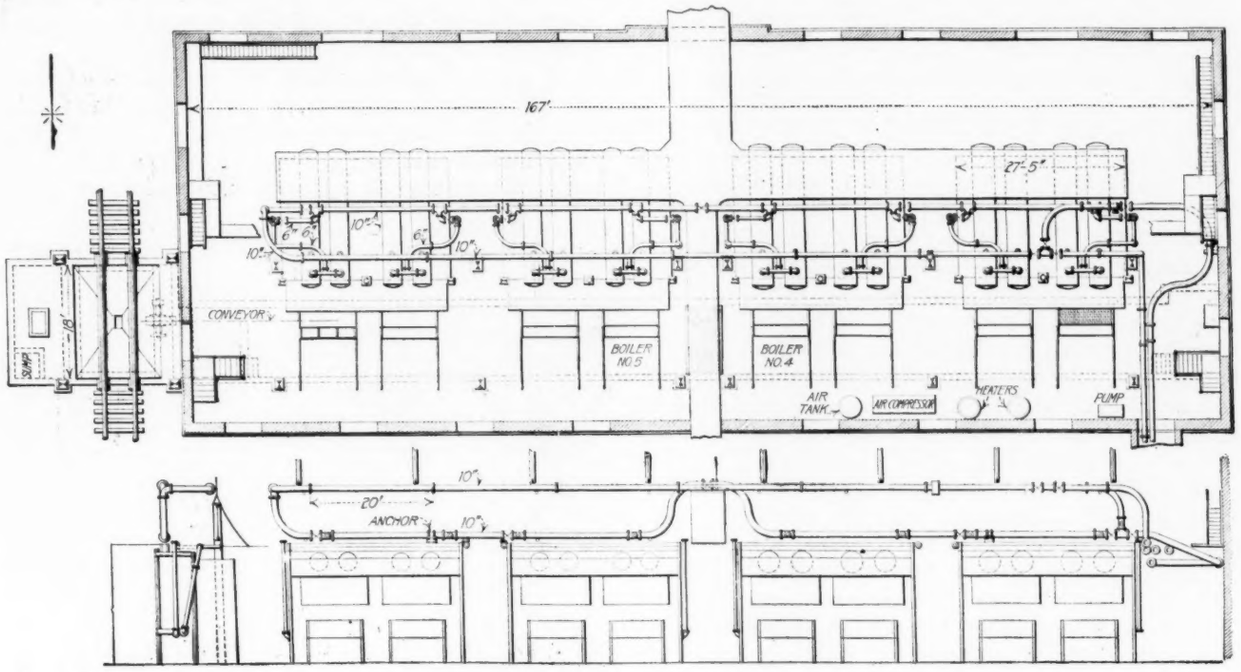


FIG. 2. PLAN AND ELEVATION OF THE NEW BADEN STATION BOILER ROOM

The boiler room of this station was completed in 1398. The equipment consist of four batteries of two each, or eight 277-hp. water-tube boilers each of which is equipped with down-draft type of furnaces. The boiler plant at present is well taxed to its capacity during periods of maximum pumping, and is in immediate need of enlargement. The boilers are in their twentieth year of service, having done duty practically continuously day and night, and they have already been running longer than what is considered the usual life of boilers of this type. In Fig. 1 is shown an interior of the present boiler room and indicates the attendant requirements in man-power with these old-type hand-fired boilers for handling coal and ashes. The tube spacing of the down-draft furnaces is such that the large-sized coals must be bought for fuel.

The following is taken from the annual report of 1917 and shows the saving that can be effected by remodeling

Total coal burned, tons	23,000
Price per ton	$1.35
Cost of screenings	$31,050
6 firemen at $90 per month	6,480
8 coal passers at $65 per month	6,240
1 boiler-room fireman at $75 per month	900
2 boiler washers at $90 per month	2,160
Interest on investment at 6 per cent	10,650
Total cost to generate steam	$57,480
Cost per 1,000 lb. steam	$0.199
Yearly saving possible	$11,797

This represents a saving on the investment ($177,500) of 6.6 per cent. even during these times of high prices.

It may be of interest to relate some of the symptoms of age in the boilers. Each unit has two 36-in. drums which were originally of material $\frac{5}{16}$ in. thick with longitudinal, triple-riveted lap joints. The old tubes are requiring continual renewal, as hydrostatic tests to 150 lb. after turbining, invariably reveal leaks, with the consequent removal of from two to eight tubes. These

tubes, when cut to pieces, have commonly shown weak spots. During the last year a tube rupture which occurred in the sixth bank caused a temporary shutdown of the entire station. If it were not for the immediate reconstruction of the plant the boilers would all have to be retubed.

The plant will furnish steam at 150 lb. pressure and 150 deg. superheat. The type and size of new boilers

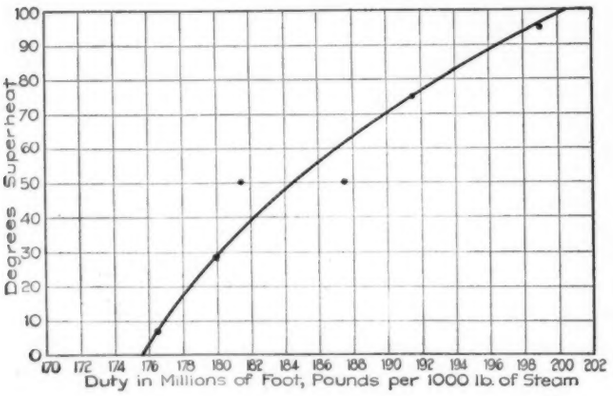


FIG. 3. CURVE SHOWING THE RESULT OF TESTS

determined upon for the remodeled Baden station was governed by the water-tube boilers that were removed from the high-service station No. 1, due to connecting the engines of this station to the boilers of the high-service station No. 2, as already mentioned. These boilers, four in number, are in good condition, each of 410 hp. capacity, and will be dismantled and reinstalled together with their superheaters at the Baden station. In order to maintain uniformity of parts throughout the boiler room, four new boilers of the same type and size will be added. The total plant capacity will be 3300 boiler horsepower which, it is estimated, will serve the pumping demands for the life of the boilers.

The boilers will be fired by chain-grate stokers with a ratio of boiler-heating surface to grate area of 48. This ratio, with a properly designed furnace, will drive the boiler efficiently at below rating and at 30 per cent. and more over capacity. The chain-grate stoker was selected as being best adapted for the purpose, considering the extent and nature of the load, the grade of coal to be burned and the amount of money invested. The daily peak of the maximum pumping periods at this plant, which pumps into a closed system, varies about from 1.1 to 1.3 of the average and from 1.2 to 2.0 of the minimum. The chain-grate stoker meets these load demands nicely, and it was considered unwise to go into a more costly and elaborate type of stoker with all attendant auxiliaries, especially in a water-works boiler plant where the reserve capacity in the equipment is larger than in most commercial plants.

The question of installing an economizer was also considered, and although a fair return on the investment might be realized, over the life of the economizer, yet with the present load and cost of economizers, and for a few years to come, it was questionable whether any gain would be realized. Provision has been made, however, in the planning of the boiler plant and in the breeching, should occasion arise in the future for the installation of economizers.

Fig. 2 shows a plan of the boiler room. Coal is dumped from the railway track into the track hopper, passes through a crusher and reciprocating feeder into a continuous pivoted bucket conveyor, which elevates it and dumps it, with the aid of a traveling tripper, into the desired bunker. The same conveyor receives the ashes from the boilers and delivers them to the ash hopper over the track hopper. Ashes may be deflected through a chute to a car on the side track or may be stored in the hopper. A conveyor of the same type, handling both coal and ashes, has been in service at the low-service station No. 2 for three years, and no appreciable wear due to handling ashes in the same conveyor has been noticed. The storage capacity of the bunkers was made as large as possible, this feature having manifested itself as very desirable during the past winter.

Fig. 4 shows a transverse section through a boiler setting. Coal may feed from the bunker through automatic weighing scales into the stoker hopper, or it may be shunted by means of a long spout (with the scales pushed aside) from the bunker past the stoker hopper into the siftings hopper and down onto the conveyor, whence it may be elevated and dumped into another hopper.

All coal is weighed as used, and the boiler-feed water is measured by a venturi meter with integrating and indicating recorders. A weekly efficiency record showing the relative station performances is bulletined at all stations. Each boiler is equipped with indicating steam-

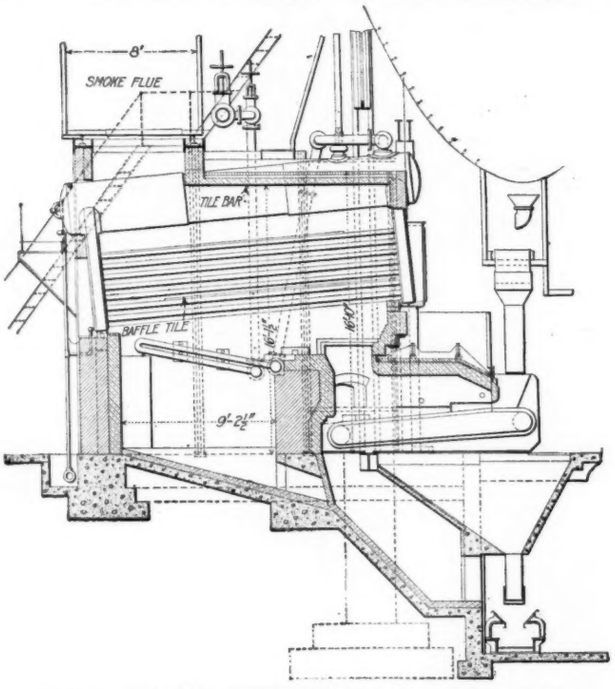


FIG. 4. SECTION THROUGH ONE OF THE BOILERS AND SETTING

flow meter and CO_2 apparatus. Stack-breeching temperatures are recorded on a continuous chart.

The steam piping was designed on the loop plan so that both in the engine and boiler rooms there will be two ways of getting steam to the engines or from the boilers. Fig. 2 shows the piping in the new boiler room in both plan and elevation. The maximum velocity in the 10-in. header alone will approximate 7600 ft. per minute. All valves and fittings will be of extra-heavy cast steel with all joints male and female faced.

A new reinforced brick-veneer smoke-stack, 235 ft. high and 9 ft. 6 in. mean diameter, will maintain a 1 in. draft at the breeching of the farthest boiler. The design was treated to conform with the style of the architecture of the station buildings.

During the reconstruction of the station the service must be uninterrupted, and for this reason the new boilers face opposite to the present ones. This permits the new breeching and stack to be erected while the old boilers are in service and throws the major part of reconstruction work out of the way of the firing aisle of the old boilers.

It is expected to have the Baden station well toward completion by the summer of 1919.

Some Characteristics of Babbitt Alloys

The melting point of both genuine babbitt and strictly lead-base babbitt is around 500 deg. F., and this is about as high a melting point as can be obtained in a babbitt alloy. The melting point of a babbitt is always lower than the arithmetical mean of the melting points of the metals forming the compositions, and variations from certain rules in mixing reduces the melting point of the mixture below that of the most fusible metal in the alloy.

As an illustration, take a mixture of 87 per cent. lead and 13 per cent. antimony. Since the melting point of lead is 619 deg. and of antimony 834 deg. F., it would be natural to suppose that adding antimony to lead would bring the mixture to a higher melting point than that of lead, say to the mean melting point of the two, about 645 deg. F. At any rate, it would not be unreasonable to expect to obtain a higher melting point than that of lead (619), but as a matter of fact the melting point of this alloy is 477 deg. F. This is the lowest melting point of the series of lead and antimony mixtures.

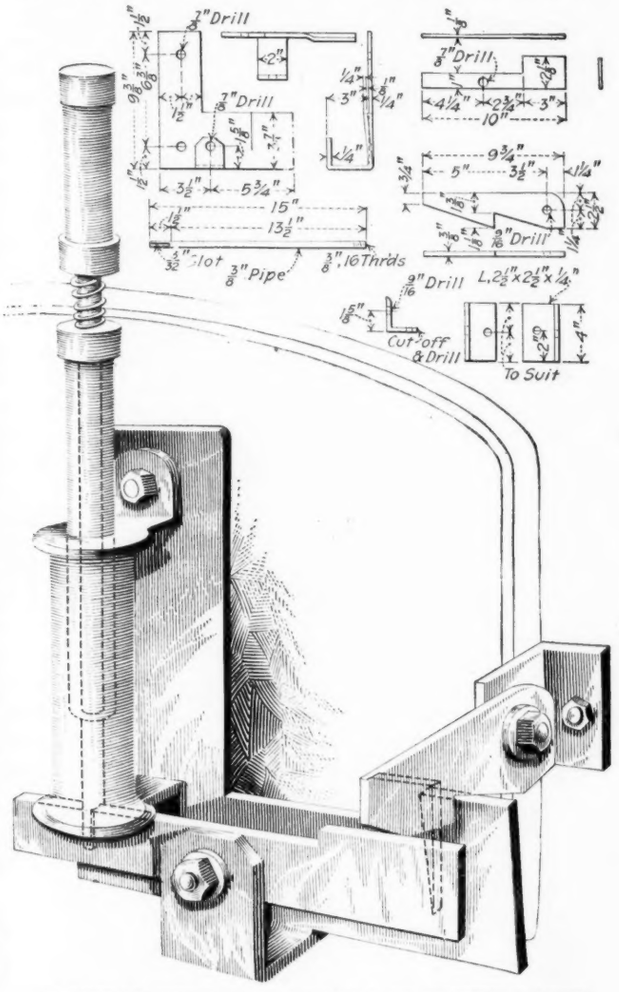
A tin and lead mixture consisting of about 60 per cent. tin and 40 per cent. lead melts at about 336 deg. F., representing the low limit, while another of about 60 per cent. lead and 40 per cent. tin melts at about 412 deg. F., representing the high limit. This latter mixture is known commercially as "wiping solder" and is used for that purpose by plumbers because it remains in a pasty stage while cooling through a range of 70 deg. F.

There is, however, a widespread belief that the cost of a tin-base babbitt can be cheapened without injury to its quality by the addition of lead, and also that the quality of a lead-base metal can be improved by increasing the tin content—this latter idea being based no doubt on the assumption that if a little tin is good more is better. But without knowledge of the effect produced in alloying certain kinds and proportions of metals, it is an easy matter to fall into grave error in compounding babbitts. Intermediate grades of babbitts have their use, but they can only be used successfully under most favorable conditions, and they generally fail under heavy pressure, high speed and scant lubrication, chiefly because of their low fusibility, which makes them highly susceptible to the influence of frictional or initial heat. As far as outer appearances go these intermediate grades seem to be most desirable, and they will also stand the usual physical tests of hammering, cutting and bending; but when put in service, they are apt to give trouble. This is generally attributed to some mechanical defect or to the lubrication, as users are in the dark as to other possible causes, the chief one being the low melting point, influenced, as shown, by the mixtures.

Safety Latch for Furnace Door

BY C. W. HOWARD

The illustration shows a safety latch for boiler-furnace doors, which I designed and put on the Heine boilers of the Celina (Ohio) Municipal Electric-Light and Water-Works plant. These latches have been in



GENERAL VIEW AND DETAILS OF SAFETY LATCH

continued use for two years, and in that time have given no trouble and have required no repairs. The parts are shown in sufficient detail, with dimensions, to permit anyone to order or construct others from them.

The object, of course, is to provide a latch that will hold the door closed and prevent the fire from being blown out into the fireroom in case of a tube failure, and at the same time one that is not cumbersome to manipulate. This device, I believe, meets these requirements and is at the same time inexpensive to make. A slight pressure on the handle above the spring raises the latch so that the door can swing open.

Interpreting Steam-Turbine Test Curves

By H. E. BRELSFORD

A brief description of standard turbine data curves, and how they are derived and used in interpreting turbine characteristics is given.

THE following curves are all based on a constant number of jets or nozzles in operation. Fig. 1, a power-pressure curve, is plotted to show the increase of power with increase of pressure at a constant speed (approximately so, varying only with governor regulation). Used simply as an indication of the turbine's power capacity, this curve shows the maximum power of the turbine. As the initial steam pressure is generally a fixed quantity, the maximum ring pressure is determined, hence the horsepower at this pressure is determined. This horsepower may be increased or diminished by using larger or smaller nozzle areas, and of course using more or less steam proportionally. Ring pressure may be defined as the pressure existing on the first set of nozzles and it is controlled by the governor. With a given speed it takes a certain amount of pressure to run the turbine at no load. This readily shows that with atmospheric exhaust the power-pressure line will not pass through the 0 gage-pressure point. As a general case this may be stated in this way: When the power-pressure line is plotted, the point at which it intersects the pressure line will be at a pressure greater than the exhaust pressure, the magnitude of the difference representing the sum of the no-load or rotation and radiation losses in the turbine. This form of curve is valuable as it may be used as a chart to show the horsepower being developed by the turbine at any given ring pressure while in operation. This curve is, of course, determined experimentally by an actual test and is a straight line.

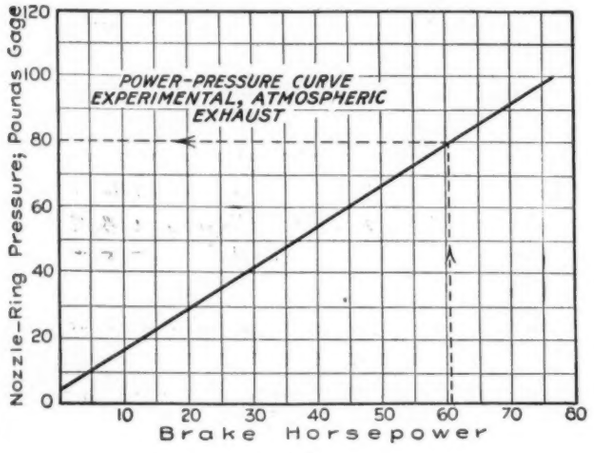


FIG. 1

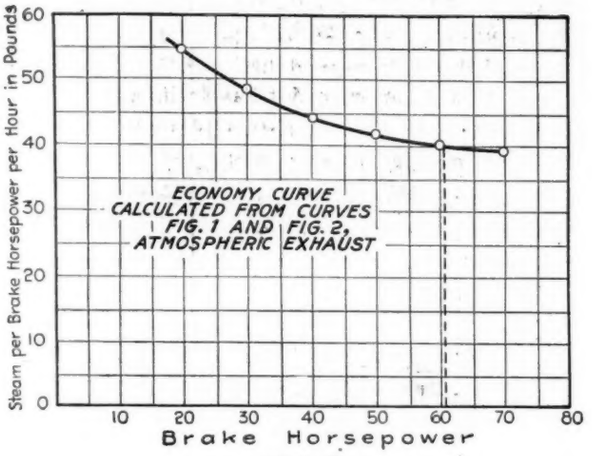


FIG. 3

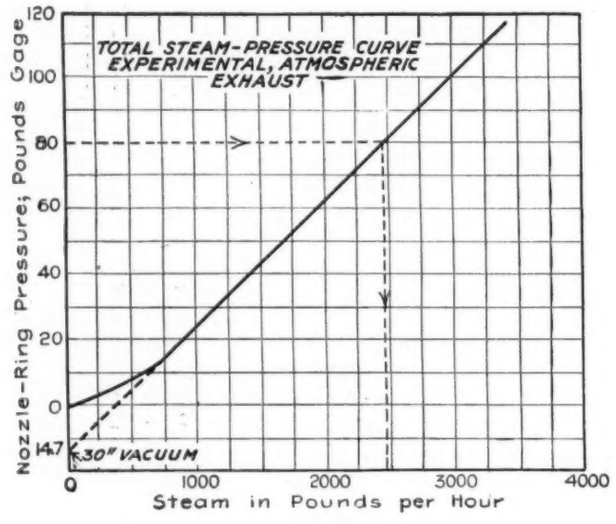


FIG. 2

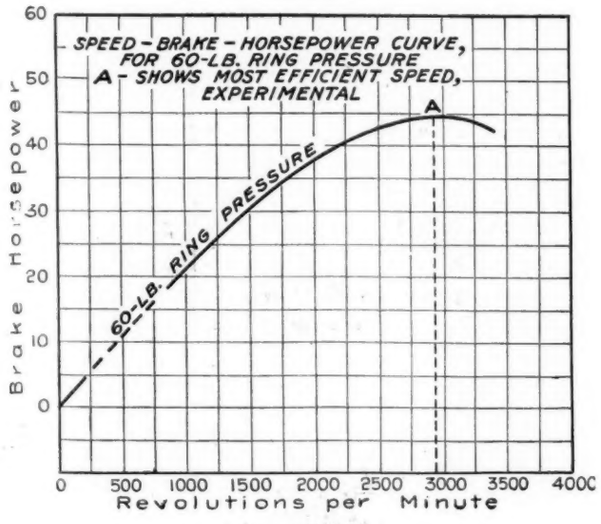


FIG. 4

FIGS. 1 TO 4. CURVES SHOWING DIFFERENT CHARACTERISTICS OF STEAM TURBINES

Fig. 2, a steam-flow-pressure curve, is plotted to show the rate of flow of steam with any pressure. This curve is also a straight line except in the region where the absolute exhaust pressure (back pressure on the jets) is

less than 58 per cent. of the absolute nozzle-ring pressure (initial pressure on the jets). In a single-stage turbine or a single-element Curtis turbine with atmospheric exhaust, with jets discharging into atmosphere, the initial pressure must be more than 10.63 lb. gage or the points on this power-pressure curve will not be in a straight line. A multi-stage turbine has the same characteristic straight-line pressure curve, but here the break is determined by the relation of the ring pressure to the pressure in the first stage. There is hardly a perceptible difference, however, from the straight single-stage turbine. On a multi-stage turbine the exhaust pressure can be carried through a very considerable range before altering the steam-flow rate.

With any nondiverging nozzles the steam flow per hour is calculated from the formula

$$W = \frac{SA}{0.04V}$$

where

W = Pounds steam per hour;
S = Velocity in feet per second of steam issuing from the nozzle;
A = Area of nozzle throat (also mouth) in square inches;
V = Specific volume of steam at the pressure into which the jet discharges;
0.04 = A constant which takes into account the time and space factors of the different quantities.

It will thus be seen that on a multi-stage turbine if the exhaust pressure is increased it raises the back pressure against each set of jets or nozzles. Each stage then can be considered as an individual single-stage turbine, and its characteristic pressure-flow line would be identical with the first case discussed. It should be noted, though, that the ratio of back pressure to initial pressure on the last stage, and hence the ratio of specific volume to velocity, is slightly different from the ratio of first-stage pressure to ring pressure. The lower end of a flow curve is, however, not of any consequence, as the real operating conditions are always at least above quarter load.

The curve, Fig. 2, at the lower end shows where the line curves to the left and passes through 0 gage pressure. If this curve was plotted to absolute pressures, it would pass through absolute-zero pressure the same as if the straight portion is produced in Fig. 2. If plotted to gage pressure the straight part produced will pass through absolute zero the same as when plotted to absolute pressure, 14.7 below zero gage. If the throat area of an expanding nozzle is known, this curve can be computed according to Napier's formula, but ordinarily it is determined by test and this serves as a check on nozzle or jet dimensions. One point determines this line, as it can be drawn through absolute zero and the given point. It is also an interesting fact that the steam flow is independent of the speed as far as can be determined in commercial testing. This fact makes it possible to make a steam-flow test with the turbine's rotor locked so that it cannot rotate. There is, however, a small difference existing, theoretically, due to the reheating effect of the greater relative velocity between the steam and the blading.

An economy, or brake-horsepower-water-rate curve, is given in Fig. 3 and is plotted to show the variation of the economy or steam rate with the output at constant speed. It is, of course, a well-known fact that the economy at partial loads is not as good as at full load, or at the load for which the turbine was designed to operate with best economy. An economy curve will therefore show an improvement with increase of load, the speed remaining constant, until a point is reached where the quantity of steam is the maximum for which the turbine was designed, and then the rate per horsepower will usually increase. This curve is derived directly from curves 1 and 2. For instance, if it is desired to determine how much steam is required per horsepower-hour when the output is 60.75 hp.: Then on curve 1 at 60.75-hp. pass vertically to the power line and from the intersection pass horizontally to the pressure line and read the pressure required to produce 60.75 hp. On curve 2 at this same pressure, 80 lb., pass horizontally to the flow line and at the intersection drop straight down and read the quantity of steam flowing at this pressure, namely, 2460 lb. per hour. This value divided

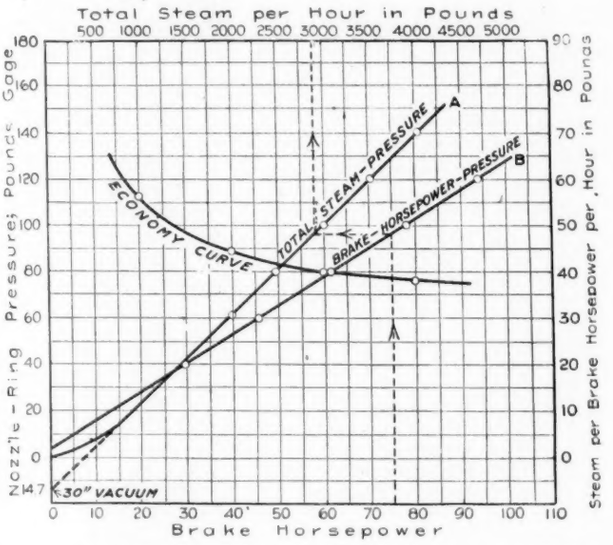

Total Steam per Hour in Pounds
500 1000 1500 2000 2500 3000 3500 4000 4500 5000
Nozzle-Ring Pressure; Pounds Gage
180 160 140 120 100 80 60 40 20 0
14.7 30" VACUUM
ECONOMY CURVE
TOTAL STEAM-PRESSURE
BRAKE-HORSEPOWER-PRESSURE
A
B
0 10 20 30 40 50 60 70 80 90 100 110
Brake Horsepower
Steam per Brake Horsepower per Hour in Pounds
90 80 70 60 50 40 30 20 10 0

FIG. 5. COMBINATION OF CURVES FIGS. 1, 2 AND 3

by the brake horsepower gives the pounds per brake-horsepower-hour; that is, 2460 ÷ 60.75 = 40.5 pounds.

These curves are shown combined in standard form in Fig. 5 together with an indication of the way one point was determined on the economy curve. The steam per brake-horsepower-hour at 75-hp. load is determined by finding 75 on the brake-horsepower line at the bottom of the figure and following vertically to the brake-horsepower-pressure line, then horizontally to the total-steam-pressure line and up vertically to the total-steam-per-hour line at the top of the figure, and read 2900 lb. total steam per hour. The steam per brake-horsepower-hour equals 2900 ÷ 75 = 38.7 lb. Find 38.7 on the pounds of steam per brake-horsepower-hour line on the right of the figure, and run horizontally to the left until the vertical line running from 75 brake-horsepower is intersected, which will give this point on the economy curve.

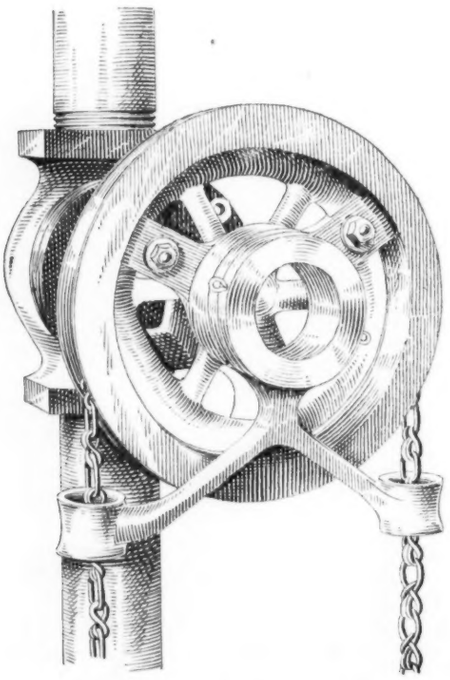
A power-speed curve, Fig. 4, is plotted to show the variation of power with speed at a constant pressure. This curve is made from tests and is used principally to show the point of maximum efficiency. Sometimes many such curves are drawn at varying pressures and thus indicate the range of the given turbine. As the pressure

increases, the velocity of the steam issuing from the jets or nozzles increases, so also the point of maximum efficiency would be at a higher speed, exhaust conditions remaining constant. Windage and friction losses, including also steam friction on the buckets, increase with increased steam and wheel velocity, hence with a given design a limiting pressure will be reached where further increase does not make the point of maximum efficiency lie at a higher speed. It is, of course, desirable to make the pressure and velocity conditions such that this maximum efficiency comes at the point of operation. The operating point is not always the full-load point for this reason:

In many cases the turbine will operate at less day, hence it is desired to have this the best economy condition. Full load would be for such a small percentage of the time that some allowance could be made in the matter of economy.

Improved Rim for Chain-Operated Valve

A recent improvement on the Babbitt rim for chain-operated valves, a description of which was published on page 560 of the Jan. 11, 1916, issue of *Power*, is illustrated herewith. By means of this rim, valves may be adapted for operation by chain, the sprocket rim being adjustable to fit different sizes of valve wheels. The improvement consists of a guard having two arms

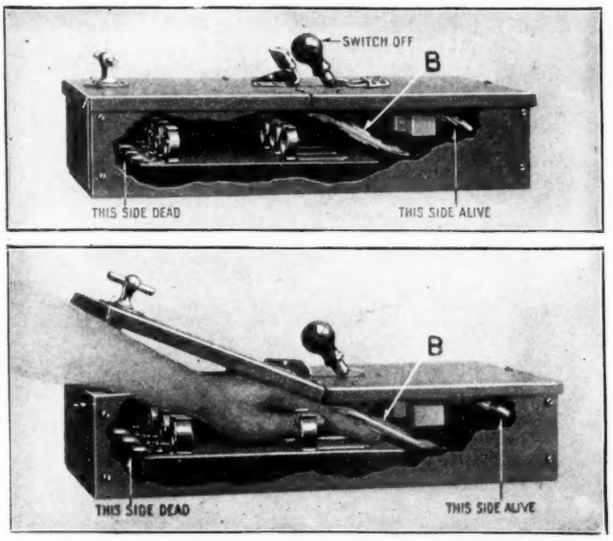


CHAIN GUIDE FOR VALVE WHEEL

through which the chain passes. In any ordinary installation a guard, to prevent the chain from jumping off the wheel, is unnecessary, but on shipboard or where the valve stem is not horizontal or where other unusual conditions exist, such a device is sometimes advisable. These rims are made by the Babbitt Steam Specialty Co., New Bedford, Mass.

Krantz Auto-Lock Switch

Wherever the workmen have little knowledge of electricity, it is desirable to use switches having no live parts exposed or accessible in the ordinary operation of the switches or when replacing fuses. To accomplish this the Krantz auto-lock switch, illustrated, marketed



SECTION THROUGH AUTO-LOCK SWITCH. TOP—SWITCH OPEN; COVER CLOSED. BOTTOM—SHOWS THAT LIVE PARTS CANNOT BE REACHED WHEN COVER IS OPEN

by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has been developed and is intended for use on main circuits or wherever an ordinary knife switch is applied. The switching parts and fuses are inclosed in a steel box the cover of which is in two parts, one being screwed on to form a permanent covering for that end of the box containing the switch, and the other part being hinged so as to swing back and permit the renewal of fuses, as shown in the figures. A latching mechanism makes it impossible to open the cover without first throwing the switch to the "off" position and rendering all fuses and other accessible parts dead. As long as the door of the case is open, the switch contacts cannot be closed.

Two padlocks can be used independently of each other, so that the switch cover can be locked shut with the switch either "on" or "off," or the switch can be locked in the "off" position with the cover either locked or open. Contact is made by means of a laminated spring-copper brush *B*, double-ended, with auxiliary arcing contacts at each end.

The double-ended brushes provide a double break, dividing the arc between the two ends, each of which is provided with a separate arcing tip. In the closed position the switch is held in positive contact by throwing a toggle over center. A spring provides a quick-break for opening, the mechanism being independent of the operating handle. These switches are supplied for 250, 500 and 600 volts, for either alternating- or direct-current service, and in capacities up to 2000 amperes.

The apparent consumption of crude oil in April was 4.3 per cent. greater than in March, 1918, and 19.9 per cent. greater than in April, 1917.

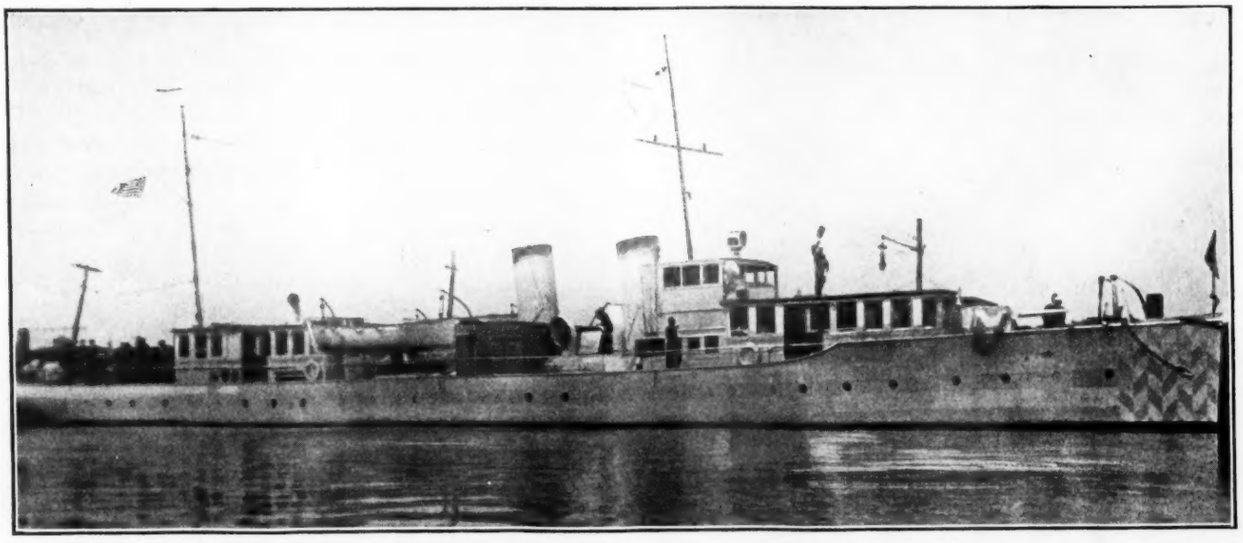
The Engine as a Reducing Valve

We often see the statement that an engine taking steam at high pressure and exhausting into a low-pressure heating system simply acts as a reducing valve. While this is true in one sense, it is well to keep in mind the difference between the two in the effect on the quality or quantity of the steam. In order to do any work the engine must abstract some heat from the steam. This may demonstrate itself in the form of water in the exhaust steam, being steam that has given up all its latent heat. Under other conditions the exhaust may still be dry saturated steam, but the steam supplied to the engine in this case must have been superheated to a greater or less degree or the steam carried late in the stroke, but there is a loss of heat just the same.

With the reducing valve, however, the case is different; the steam does no work except upon itself. The work done in overcoming the friction or resistance to the passage of the steam through the contracted orifice may be thought of as producing frictional heat that is in turn absorbed by the steam in passing, producing superheated steam at the lower pressure, just as air or water carries away the heat from a brake shoe. There is, of course, no gain in heat in the reducing valve, for it is apparent that it has no means of generating heat; nor is there any loss of heat (except the slight radiation), so there is nowhere else for all of the heat present in the higher-pressure steam to go except to be carried onward by the lower-pressure but slightly superheated steam.

This difference should be kept in mind concerning the use of exhaust steam for heating as against steam from a high-pressure boiler passed through a reducing valve or a contracted orifice such as a partly opened valve. For each horsepower-hour of work done by the engine there has disappeared from the steam not less than 2545 B.t.u. of heat. If an engine takes only 15 lb. of steam to develop one horsepower for an hour, it will be seen that about 170 B.t.u. taken from each pound of steam passing through is enough to account for all the power developed. If the engine takes 30 lb. of steam, half as many (85) B.t.u. will be taken from each pound of steam. To determine the percentage of the total heat taken from the steam in the form of useful work, it is necessary to divide 2545 (the B.t.u. equivalent of one horsepower-hour) by the pounds of steam passing through the engine per hour (the engine's water rate). This gives the B.t.u. taken from each pound of steam; this (with two decimal places added) divided by the total heat in the steam for the given pressure and degree of superheat, if any, as shown by the steam tables, gives the percentage of heat taken from the steam for each horsepower of measured work.

Friction and radiation loss is not taken into account. For example, a water rate of 30 lb. per hp.-hr. gives $2545 \div 30 = 85$ B.t.u. per lb. taken from the steam, and if saturated steam at 150 lb. gage is used, the total heat of which is 1195, then $85.00 \div 1195 = 7.1$ per cent. If a separator attached to the exhaust pipe took out all the water, there would be discharged from it about 1¼ lb. of water per horsepower-hour (plus that from radiation), since 30 lb. of steam has given up heat to the extent of the difference between 1195 B.t.u. in steam at 150 lb. gage (substitute any other pressure) and 1150 B.t.u. in steam at atmospheric pressure, or 45 B.t.u. per pound times 30 lb. (or substitute the water rate of the engine) = 1350, a little more than half the total B.t.u. (2545) called for; the remaining 1195 B.t.u. must come from some of the steam giving up its latent heat and returning to a liquid state, to water. In doing so each pound will, of course, give up 970.4 B.t.u., so that $1195 \div 970.4 = 1\frac{1}{4}$ lb. (approximately) of water would result. The radiation loss is no greater than would result from an equal surface and temperature difference, and leakage may or may not be considerable. The 28-odd pounds of dry saturated exhaust steam from this engine is therefore of the same value for heating or like purpose as saturated steam generated at the same pressure in a low-pressure boiler.



U. S. S. "GEM," SCOUT PATROL NO. 41, ASSIGNED TO THE SUBMARINE DEFENSE ASSOCIATION. ONE OF ITS PRESENT USES IS THE TESTING OF VARIOUS SORTS OF FUELS

[It was our privilege recently to take part in a cruise during which the fuel used was powdered coal burned in an apparatus installed by the Fuller Engineering Co. So far as we know this is the first boat to be run with this kind of fuel. The test of "colloidal fuel," which is powdered coal suspended in the colloidal condition in fuel oil, described in our issue of May 28, 1918, was also made upon the "Gem."—Editor.]

Compulsory Co-operation of Central Station and Isolated Plant

By S. R. SAGUE

Correspondence with city officials of Cleveland, Ohio, the Fuel Administration and others, concerning the advisability of enforced coöperation of public-service and privately owned plants, so as to avoid duplication of distributing systems and prevent waste of coal.

RECENT experience indicates that, if a statement is repeated often enough, people will come to believe it This seems to be the crux of the central-station controversy with the isolated plant. The central station has declared again and again that it is cheaper to buy power than to make it in individual plants, and it is astonishing to note the inroads that such propaganda has made into good engineering.

In urging the adoption of purchased power the motives of the central station are ulterior. The question as to whether it is better, from a financial viewpoint, for the client to operate his own plant, is never considered. Therefore, the writer for several years has endeavored to bring about an arrangement whereby such a matter could be handled as an engineering problem and solved to the best advantage of all. But such coöperation does not exist in the policy of the central station.

Happily, I believe that the day is here when such co-operation must be effected. The large commercial coal requirements of the United States are north of the Mason and Dixon line, and all factories, with but few exceptions, north of this line require heating in the winter. In line with the idea of coöperation, I wrote the mayor of Cleveland, Ohio, on July 10, 1917, the subjoined letter. Cleveland operates a municipal central station erected to compete with the privately owned plant of the Cleveland Electric Illuminating Co., and the rate for service was fixed at one cent minimum and three cents maximum.

I wish to call your attention, at this time, when conservation seems to be the watchword, to a matter whereby considerable saving could be effected in this community in the conservation of coal. A manufacturing city such as ours, situated in a climate subject to the rigors of winter, must have three commodities, inseparably associated; namely, heat, light and power, and all three are derived from coal. To obtain light and power we must produce heat, and to burn coal to produce heat only we lose energy which could be converted to light and power and still leave as much heat for heating as before. To make light and power and dissipate the exhaust steam to the atmosphere or condensers is to lose the heat value of the exhaust steam.

The campaign of the Illuminating company and the municipal light plant to obtain power users is a campaign of inefficiency, at least for the winter months, and one prompted entirely by selfish motives. Both the Illuminating company and the municipal light plant are a necessity, but they do not take a sufficiently wide view of all the requirements of the city for light, heat and power. They emphasize the power and light features to the neglect of the heating, and consequently there is partial duplication of the coal requirements of the city as a whole. The large central stations can make current for power and light cheaper than the small isolated plant; but in the winter-time it is not possible in a majority of cases for them to furnish light and power and have the manufacturer furnish heat, and have the combined cost of light, heat and power as low as though the manufacturer fired his own boilers and obtained light and power to the extent of his requirements, and had his heat besides.

In some cases the coal requirement for heating certain factories is in excess of the requirements of those factories for power, in which case the excess current generated would be disposed of advantageously; for if all boiler plants for heating purposes would, in the winter at least, pass their steam through engines to the extent of the heating requirement, the generators these engines would drive could be paralleled with the distributing system so as to pump back on the line any excess power over the particular factory's requirements, which would then be available somewhere else, where less heat but more power would be required.

The central stations would act to smooth out the system, just as the reservoirs on our water systems take the come and go of daily varying requirements. In the summer all coal would be burned most advantageously at the central stations. This, as regards factory requirements, would taper off in the spring and fall to a minimum in the winter. In the summer, most chimneys, except where process steam is required, would be smokeless, aiding the housekeeper and keeping our city clean when we want cleanliness most. We would not mind our usual soot in the wintertime. By this, 25 per cent. less coal would be burned and real efficiency obtained.

Furthermore, the two power companies are duplicating transmission and going into the same territory. One line or distributing system could be made to do if the municipal light plant and the Illuminating company were hooked in parallel and both delivered power to the same distributing system, just as railroads operate over each other's tracks on an agreed compensation per car mileage, or as oil wells pump into a common pipe line. The oil the pipe line delivers to the owner at the terminal is not the actual oil he pumped, but is oil of the same gravity and test, just as the electricity would be of the same cycle and voltage. There is no more need for two electric distributing systems than there would be for two water systems or two gas systems.

For the city to buy a coal mine and bring in power and light over high-tension transmission lines would not relieve the coal shortage except as regards the use of coal by the light plant, because the same amount of coal for heating must be spent as heretofore, and there lies the great bulk of the manufacturer's real coal problem. This, however, would also help the Illuminating company in case of shortage, if both systems were tied together.

This communication was acknowledged by the mayor, who referred it to the commissioner of light and heat. I next received a letter from the commissioner of light and heat, which, for various reasons, I prefer to withhold in this communication, but its context may be surmised from my reply of July 27, 1917, as follows:

I am afraid you overlooked the main point in my letter, namely, heat as well as light and power; also, it was my intention to treat of power users or factory loads entirely, and not domestic.

It is manifestly impossible to heat either a factory or a home with electric current, no matter how cheaply you get your coal. One unit of electricity costing one cent is equivalent to 3413 B.t.u. One pound of coal contains, say, 13,000 B.t.u., and one ton would then contain 26,000,000 B.t.u., and using arbitrarily an efficiency of 50 per cent., which is low, you would get 13,000,000 B.t.u. from a ton of coal, which would be equivalent to 3809 units of electricity costing $38.09 on a basis of one cent per unit. With coal at even $10 a ton the domestic user could not afford to heat electrically, much less a factory using even cheaper steam coal.

Any proposition covering the generating of current either here or at a mine must be on the basis of power and light only—not heating. You will see that the point of my letter dwelt largely on the question of heat in combination with light and power. They cannot be separated, as all originate from coal, and any factory requiring heat makes a potential

light and power equivalent whether it knows it or not. In other words, if each pound of coal could be made to deliver its total equivalent in heat as well as in light and power, we would make enormous savings.

You lose sight entirely of my suggestion of one distributing system for both plants. This would immensely improve the load factor, which you say is desirable. The stand-by losses and reserve apparatus necessary for sudden increases in load would be reduced by one common distributing system, as these items are now in duplicate, whereas only one set need be held for emergencies. In fact, by an equitable arrangement with the Illuminating company, the municipal light plant could be run at a maximum at all times, whether generating here or at a mine, pumping its current into a common distributing system.

You state that the immense heating load comes on in winter, requiring enormous capacity. This is not so if you arrange one distributing system and have each factory make current, using exhaust steam therefrom to an amount necessary to heat, and pumping any excess current generated back on the line for use elsewhere. I still feel you have missed the point of my letter and the thought contained therein, and your solution still must consider heat, light and power inseparably in the commercial field at least, which in turn will aid the domestic field on light and power only. Electric heating is a mirage.

To this I received no reply—central stations do not like to discuss heating—but it illustrates how any effort is smothered. Along this line, I sent a circular letter to a list of power users. One of these letters was forwarded to some central station, with the result that I received a letter from the Society for Electrical Development, Inc., as follows:

Our attention has been called to a circular letter sent out over your name, advocating the installation of isolated industrial plants, and claiming that it is more economical to burn coal in such isolated plants than it is to take central-station service, the claim being made that this is one way of conserving coal. The letter speaks of statistics proving this. We are very much interested in the subject and would appreciate it if you would kindly send us the figures upon which this statement is based.

To this I replied under date of Mar. 13, 1918, as follows:

The writer was interested to receive your communication. We are rather under the impression that your society is, as the letterhead states, a corporation for coöperation, but only so far as it benefits the central station. We may be misinformed in connection with this and, if so, would appreciate your setting us straight.

We, in our work, have endeavored to view the positions of the central station and the isolated plant from an engineering standpoint, and make no effort to encourage the installation of an isolated plant where we believe central-station service is the best. However, we believe that the central stations do not take this attitude, but claim that the installation of central-station service is always best, speaking from the user's standpoint. With this position we cannot agree.

We cannot conceive that central-station service is more economical where the heating load is the principal item to be considered. The central station has made an effort to shut down many power plants where the coal consumption for heating has been equal to or greater than the actual amount of coal required for power purposes. During the winter months, this requires the plant so served to burn the same amount of coal as previous to its connection to the central station, and also compels the central station to burn additional coal for supplying the power formerly supplied in the isolated plant, which still retained exhaust steam for heating.

You are entering into a discussion which has a great many ramifications, and the answer to the argument is the particular installation under discussion at the time. A general blanket answer cannot be formed.

The average manufacturer is less posted on his power plant than on any other department of his establishment and is subject to the influence of a salesman who can often put before him figures which are not borne out by facts. We are sorry to say that many installations in this territory have been made for central-station connections on this basis, rather than on the basis of engineering. It is also a question as to where the central station becomes large enough to have economies such as will enable it to sell advantageously to a user whose isolated plant is of such size that reasonable economies could be secured in it.

We believe that the Society for Electrical Development, Inc., should establish a policy and recommend to its associates the inadvisability of having solicitations made for the purpose of getting central-station connection regardless of the actual figures entering into the engineering requirements. You must admit that power generated from the coal required for heating during the winter months is a byproduct of considerable value, particularly in the face of the present price of coal, and this value is a national asset which should be conserved, even if it does not tend to the direct interests of the central stations to conserve it.

We have had the pleasure of recommending central-station service in a great many instances, and probably have as much apparatus connected on the central-station service as any company in the United States, from our motor sales department; but we must consistently recommend either central-station connection or the installation of an isolated plant on the basis of the best interests of the person served.

In response I received a very courteous letter of acknowledgment, to which I replied as follows:

Most certainly we believe in central stations. They are as necessary to our economic development as water-works or street cars; but we do take issue with central stations when they endeavor to secure connections which, upon careful investigation, show not to be to the advantage of the subscribers. When we speak of central stations, we mean such large installations operating condensing, as can show economies superio to the average isolated plant, when the cost of generating current alone is considered; but we do not believe that the average central stations, so called, in some of the smaller towns, are in position to compete with isolated plants of sometimes approximately equal capacity, particularly when the reclaimed value of the exhaust steam is available for heating. With the small central station, running noncondensing, such heat is thrown into the atmosphere or, if running condensing, into the condensers. This heat is a manifest loss and should be, as far as po.sible, conserved with the idea of cutting down the coal requirements of the country to the lowest possible point.

However, this was referred to the Fuel Administrator, and I was in due time written by him, whereupon I replied as follows:

To answer your question, let me ask you another: If a firm requires 100 boiler horsepower to heat a factory (say 3300 lb. of steam per hour at 5 lb. pressure) and is buying from the central station 1000 kw.-hr. per 10-hour day to operate machinery, what is the national coal loss in that individual case per day?

Answer: The amount of coal used by the central station to generate the 1000 kw.-hr.

You will agree that the following statements are pertinent to the discussion for the northern section of this country, which is the large coal-using as well as manufacturing section of the nation:

1. In this latitude for five months we positively must heat our factories.
2. Fuel transportation during the heating season is more difficult than during the nonheating period.
3. Complete recovery of all values (heat, light and power) from every pound of coal is necessary, particularly during the heating season.
4. The isolated plant during the nonheating months may lose some of the gain made during the heating months.
5. Eliminate, as much as possible, during heating months the enormous heat values dumped into condensers by central stations to make low generating costs.
6. Burn coal economically in isolated plants to heat by exhaust steam and use current generated as well for power.
7. Admit the economic necessity of central stations and isolated plants.
8. Connect to the central station where economies can be shown to be in its favor.
9. Operate isolated plants where coal savings warrant.
10. Review the entire matter from an engineering standpoint.
11. Prevent solicitation of commercial enterprises as power users by central stations for selfish gain, regardless of the national coal pile.
12. Prohibit central stations from taking on power users at a lower rate than cost to produce current for the purpose of keeping up volume in central station.
13. Compel isolated plants to arrange to burn coal eco-

nomically. Allot isolated plants only such coal as they would require if operated economically, thereby compelling savings by the installation of economical apparatus.

No acknowledgment was received, so I wrote again:

We had the privilege of writing you with reference to isolated plants versus central stations as power-producing units, and their advantages from the coal-saving standpoint. Up to the present, the writer has not had the pleasure of hearing from you further, and wonders if he can be of any assistance to you in this matter.

We recognize that it is not advantageous for the central station to name a rate for short-time connection, such as the summer months; but if the central station were paid an amount for the nonheating season for power on the basis of the cost of producing the power in each individual isolated plant, it would be decidedly to the advantage of the central station to accept such a connection, and it would not be to the disadvantage of the proprietor of the isolated plant to pay to the central station the amount which he otherwise would have paid anyhow.

In this way we would throw the load on the central station, with a minimum of coal consumed in the summertime, and throw the load on the isolated plants and conserve the heating value of the exhaust steam in the wintertime, and make a tremendous saving all around.

So far, no acknowledgment has been received.

Now, the whole system is one of inherited policy—a selfish policy, a policy of "get while the getting's good"; but a foolish policy, a policy founded upon apparatus in isolated plants of a design and pressure of thirty years ago, a policy which the central station thinks is advantageous to them when, in fact, it is not, if they would view it from the standpoint of good engineering.

The central station should get some load from all. If such a policy had been in effect prior to the war, how flexible would have been our response! We could quickly arise to the requirements, instead of having thousands of important industries hanging upon the hope that nothing will happen to the central station. A flash on some turbine would shut down thousands, while trouble with an isolated plant is more quickly repaired and affects only those workmen in the one plant.

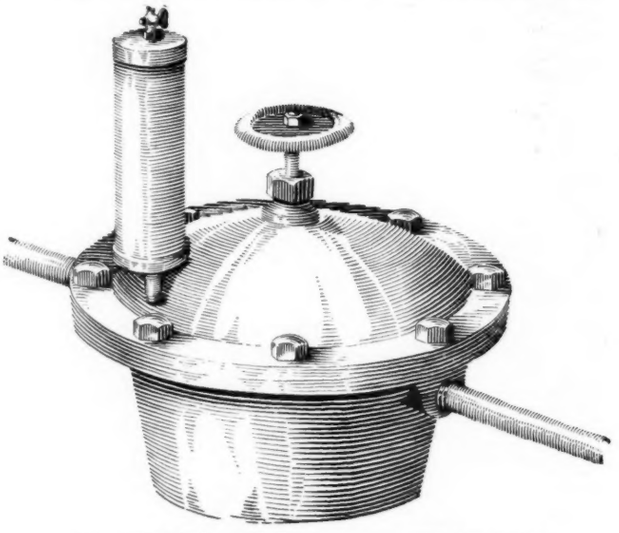
Saving coal is possible only to the extent that we can recover all values of heat, light and power, and charters for public utilities should require a filed report of all conditions of each prospective central-station user, from an engineering standpoint. This report would be referred to a properly constituted committee of disinterested engineers who would issue a permit for a given number of units from the central station per year, which would be the total amount required less the number of units that could be generated by the coal used to heat by apparatus of maximum economy.

[Through the influence and the financial assistance of the National Council of Defense, an agreement has been entered into between the Cleveland municipal light plant and the Cleveland Electric Illuminating Co., providing for an exchange of power between the two. The electrical connection of the two stations will practically guarantee war plants against shutdowns due to failure of power.—Editor.]

Air-Bound Steam Traps

By M. A. Salier

In a woodworking plant a number of live-steam coils were used for drying lumber, and these coils were drained by high-pressure steam traps. Because of the air which found its way into the coils, the traps became airbound and sluggish in operation. Instructions were given to open the pet-cocks and blow out the air from the traps at frequent intervals, but as is often the case, the instructions were soon overlooked. The engineer equipped each of the traps, as shown in the illustration, with an extra chamber made of pipe fittings, giving added space for the air so that the traps would operate a longer period without attention. Such an auxiliary chamber might be used to advantage in other cases where similar trouble occurs.



AIR CHAMBER ATTACHED TO STEAM TRAP

Method of Squaring Mixed Numbers and Extracting Square Roots

By John S. Carpenter

No claim of originality is made for the following method of squaring or extracting the square root of mixed numbers, as it is an application of the binomial theorem, but in fifteen years of practice I have never seen it introduced by anyone else. It is used with accuracy on the slide rule when there are decimals to be obtained. To the average operating engineer the conventional method has its terrors. This way involves very simple operations which are easily checked, at a glance in many cases. Most tables do not have squares of fractions.

Let it be required to square such an awkward number as 14½. From a table or the slide rule we have as the square of 14 the answer 196. Now to this add twice fourteen times ½, which is 7; also add the square of ½, which is $\frac{1}{16}$; the total is then 203 $\frac{1}{16}$. Try another, say 30⅜. The square of 30 is 900; twice 30 times ⅜ is 7.5; ⅜ squared is $\frac{9}{64}$, or 0.015625; adding, we have 907.515625 exactly.

Let it be required to extract the square root of 1121.56. Looking down the column of squares in a table, we see that the square of 33 is 1089; deducting this from 1121.56 leaves 32.56; dividing this by twice 33 gives 0.493; the answer then is 33.493. If we quibble over the last figure, square 0.493 and deduct it from 32.56, which is then 32.32; divide anew by twice 33, and we have 33.490, a little closer. For most purposes it will not be necessary to deduct the second square.

In a drafting room where the grade of help was not of the best, men who fell down repeatedly on the conventional method mastered this one with ease.

About Preventable Boiler-Room Losses

The shadow of the central station looms over the head of an engineer of an isolated plant. He is told of a few things that could be done to better the condition of his boilers and is promised a surprise in the difference in fuel consumption if the suggestions are carried out.

ONE evening as Willis was making his way home from his plant he went by a roundabout way and stopped in to visit with Joe Beards, the engineer at the Bartlett Tool Works. The plant consisted chiefly of four return-tubular boilers, and a Corliss engine drove a generator that supplied power and light for the plant.

"How goes things?" asked Willis, as he helped himself to a chair and lit his favorite pipe. "You got through the coal shortage without getting down and out, I hope."

"Just about and no more," answered Joe, seating himself in another chair. "Some days I was on the

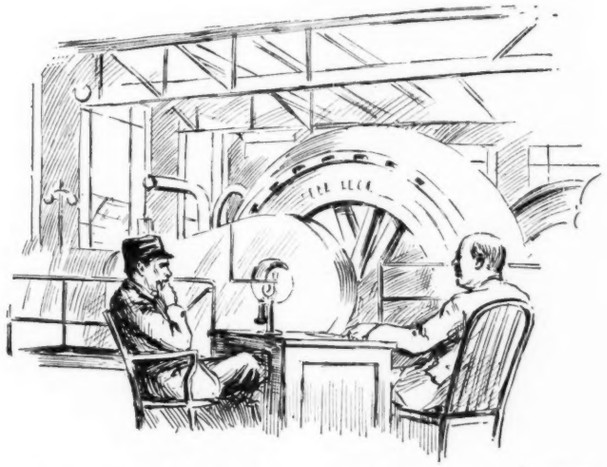


FIG. 1. "I NEVER RAN A BOILER TEST AND NEVER EXPECT TO," SAID JOE

ragged edge of nothing, as you might say, and the boss was about to throw up his hands, shut down the plant and run with central-station service. He says they have given him figures that about convince him it would be cheaper in the long run. If he does that, it will let me out, that's sure, but I don't see that I can do anything about it, do you?"

"Joe, if it were my plant, I believe that I would have considerable to do about it. If it were my plant, I would take figures to the 'old man' and show him that he could run his own plant cheaper than he could buy outside current."

"You might do it with your plant, but I can't with mine because I don't know what the operating costs are."

"Well," replied Willis, "if I were you I would get busy and get some inkling as to what it was costing to run this place. You certainly can stop all preventable waste whether you know what it is costing each year to operate or not. Take, for instance, your boiler room. How great are the preventable losses? You say you don't know, but I take it that your plant is no better than the average, and if that is so about 8 per cent. of your furnace losses in fuel consumption could be cut out. Because you burn a lot of coal is no reason to assume that you are making a lot of steam. Some furnaces can make a boiler evaporate an average of, say, 9 lb. of water per pound of coal, and the best that is obtained from others is about 6 lb. of water per pound of coal. Now with which do you think your outfit averages up?"

"I don't know," answered Joe. "I never ran a boiler test and never expect to; in fact, I don't know how. What good would it do, anyway?"

"Well, seeing that you have mentioned it, a boiler test wouldn't amount to much unless your boilers and furnaces were in fit condition in the first place. There wouldn't be much use in starting anything of that sort, because a satisfactory test cannot be had unless the furnace is in shape, and furthermore, when it comes to evaporation tests, the kind of boiler that is put over a furnace cuts a big figure, and more than that, the condition of the boiler cuts still another figure."

"Hold on a minute before you get all out of breath," interrupted Joe. "You just said that some tests will show an evaporation of 9 and some 6 lb. of water with each pound of coal burned. What's the reason?"

"Generally, it is because one furnace is better than another, although the quality of the coal will have a lot to do with it, as well as the condition of the boilers. A furnace, to be efficient, must be one that will burn the most combustible with the least surplus of air."

"How are you going to find out what is the proper amount of air?" was Joe's next question. "You can't see how much air is going into the furnace."

"By gum, that's right, I hadn't thought about that; but for all that you can tell all right if you only know how, and that is by a flue-gas analysis. When you burn a fuel in a boiler furnace, you will get two principal gases, carbon dioxide (CO_2) and carbon monoxide (CO), and the amount of each in the flue gases is determined by the amount of air that gets into the boiler furnace. The greater the volume of excess air the lower the percentage of CO_2 and the greater will be the loss in fuel. Reasonably good practice will call for about 40 per cent. excess air, which would give about 14.5 per cent. CO_2. If the excess air is raised to, say, 100 per cent., the percentage of CO_2 will decrease to about 10, and the fuel loss will be about 17 per cent., and the more excess air that gets into the furnace the lower the CO_2 and the greater the fuel loss."

"A fellow was telling me something about CO_2 awhile ago," remarked Joe. "He said that a smoking chimney meant low CO_2. If that is the case, I guess Joe Simmons over at Skinner's factory must be having a steady run of low CO_2, because his chimney smokes about all the time."

"I calculate you ain't making any mistake in your assumption, but don't you kid yourself into believing that it's the smoking chimney only that indicates poor furnace conditions. A clean chimney may show, and at the same time four or five times the proper amount

of air may be passing through the furnace and over the boiler-heating furnace with the corresponding low CO_2."

"As far as I can see," said Joe, "you have to have an instrument to find out what the CO_2 is in the flue gases, and it costs money. In this plant I don't see that I will get very far as an expert operator of a CO_2 machine."

"Perhaps not just at present; but if you'll do your part, I don't think you'll have any difficulty in getting any apparatus to assist you in running the plant cheaper. One thing you can do for a starter is to either buy a draft gage or make one. They don't cost much, but if the company can't raise the price, you can make one by bending a piece of glass tube into the form of U-tube" (Fig. 2) "and connect one end of the tube to the furnace. The draft in the furnace is of more importance than most engineers seem to think, and it has a good deal to do with the amount of coal you burn. Then you should also have a thermometer for taking the temperature of the gases going to the chimney. The furnace temperature of a boiler will be around 2400 deg. The more heat that is absorbed by the boiler heating surface the lower the temperature of the gases going to the chimney. Now, what do you get?"

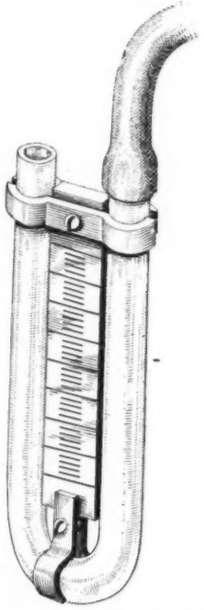


FIG. 2. HOME-MADE DRAFT GAGE

"Search me, I never had a thermometer in the place. About what should I be getting?"

"I take it that you are getting close to 600 deg.; probably higher. You likely have scale on the shell and tubes of your boilers, soot on the inside of the tubes and cracks in the brick setting. Outside of that and a leaky safety valve and a blowoff valve, I guess your boilers are about on the average."

"How do you know that there is scale in my boilers, soot in the tubes, leaky valves and cracks in the boiler setting?" asked Joe in surprise.

"Deduction, Joe, nothing else. I know the rest of us engineers in town have scale and enough of it to fight, and it keeps us on the jump, so to speak; but in the last six months you haven't cleaned your boilers—you told me so—therefore they must have scale. As to soot, you haven't anything but a piece of pipe to blow tubes with and it is covered with cobwebs. I saw them when I came through the boiler room, as I also saw the cracks in the boiler setting. The cobwebs show that the blower had not been used for some time, and the cracks show no signs of any attempt having been made at stopping them up. The escape pipes of the safety valves were dripping water and leaking steam, and the blowoff pipes were hot when I passed them; both sure indications that they leak, and that is about enough for one time.

"The thing for you to do before you begin to bother with CO_2 is to stop up the cracks in the boiler settings, clean out the scale in the boilers, blow the tubes every day and scrape them at least once a week. Don't forget to grind in the safety valves as well as the blowoff valves. I know your safety valves are of the old ball-and-lever type and should not be allowed to be used, but they'll have to go for awhile, I take it. I'll bet you a bag of peanuts that you'll see a difference in the coal bill if you will fix things up as they should be. If your chimney-gas temperatures are high now, and I guess they are, you will find that with clean boilers they will be lower; yes, considerably lower.

"Then you will find that your fireman won't have to force the fires so hard. You see, it is only necessary to keep the temperature of the combustible gases high enough to allow of their combustion. An extremely high temperature, while it has advantages, also has disadvantages due to the danger done to the furnace lining. High temperature in the rear of the combustion chamber is not an evidence of efficiency, as it may be caused by the gases being burned in the rear connection, and striking the cooler heating surfaces of the boiler, these gases will pass to the chimney but partly consumed. The hotter the gases entering and leaving the tubes the more heat is wasted in the chimney.

"Then for a change you might go into the boiler room a little more frequently and jack up the firemen once in a while just to let them know who is boss. I noticed as I came past the ash pile that there were some mighty big clinkers."

"Yes, I have noticed that myself. It must be the coal we have been getting."

"Perhaps it is," answered Willis, "but I'll make a guess that it's because the firemen carries thick fires and keeps stirring them up. That will do it, and running with the ashpit doors closed, which preheats the air in the ashpit before it goes up through the grate, will help make them."

"I don't see what a thick fire has to do with making clinkers," said Joe, as he glanced at the clock to see how near shutting-down time it was. "We have to carry enough fire to take care of the load, that's certain."

"I'll tell you what it does. A thick fire cuts down the air supply and so lets the ashes become heated. If plenty of air passes through the fuel beds the air absorbs the heat in the grate and ashes and keeps them comparatively cool. When the fireman runs a bar under his fire to break it up, he brings ashes up into the fuel bed where it fuses and forms clinkers. This lifting of the ashes and clinkers from the grate allows the live coal to fall upon them and this will overheat the grate. The thicker the ash bed and clinker the greater is the air supply cut down. It is better to carry a thin fire because a better air supply is possible if you do."

"All right, Willis, you have had quite a whack at lecturing on do and don'tless things. You told me to get a draft gage. Now, tell me, what shall I do with it after I get it? What work will it do in the first place or any other place?"

"Well, you lunkhead, a draft gage will tell you how much draft measured in inches of water you are getting. For two cents you can't tell whether the draft is poor or good, as the case might be. A draft gage will tell you what draft you are carrying, and it is of considerable importance. If there wasn't draft, there wouldn't be much of a fire in the furnace. If there is too much draft, there is the danger of getting too much air, which would reduce the CO_2 we have been talking about.

"To burn coal to the best advantage, the draft must be regulated. You cannot regulate your draft unless you know what it is, and if you will try it out you will be surprised at the difference such a small item as a twentieth of an inch in a draft will make in the amount of coal burned.

"With the boiler run at its rating, the approximate draft will be about 0.25 in. of water, but you would have to experiment to find out what would be the best draft to carry with your load and boilers. The least draft that you can carry and still make steam for the load to be carried, the better, although this can be carried to extremes in cases where the grate area is excessive. The only proper way to know the correct draft is to analyze the flue gases, which you can't do as yet. The damper is the proper method of regulating the draft, although many firemen will do so largely by closing the ashpit door, and in doing this the air pressure is increased on every other part of the boiler settings where cold air reaches them, and the more cracks in the boiler settings the more air is drawn into the furnace through them.

"You take my advice and get after a few of the things around the plant that are helping to prevent Uncle Sam from licking Kaiser Bill and at the same time are working you out of a job, and see if things don't look a little brighter as far as keeping your plant going is concerned if no more. Now don't throw up your hands and say it can't be done. Think it over, and while you are doing that I'll toddle along home and shake my fist at the table."

Purchasing Power-Plant Equipment

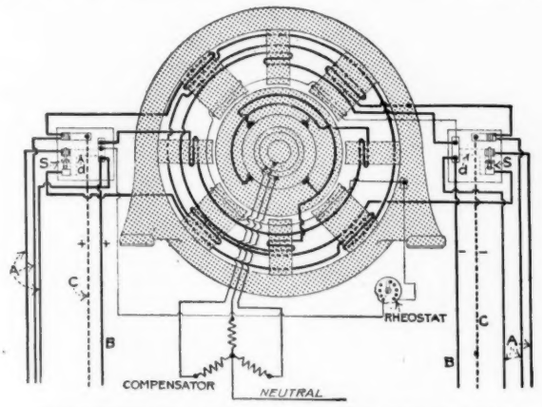
Cases are all too common where the purchaser is seemingly unaware of the operating characteristics of the machinery being bought, when considered in relation to its operation with machinery previously installed, and where the builder's representative gives the desirable features only of the new equipment and says nothing about the changes in the existing plant that he knows will be absolutely necessary to the operation of the plant as a whole after the proposed machinery is installed. One instance in mind will emphasize the need of a more candid exchange of engineering knowledge between the manufacturer's representative and the purchaser, especially when it is evident that the latter is not technically up on the problem under consideration.

Previous to my connection with my present employer, the management bought a motor-generator set, which was installed in one of the plants being gradually changed over from direct to alternating current. The plant at that time contained three direct-connected 220-volt direct-current units, all of which were compound wound. These units were operated on a 110- to 220-volt three-wire system, with the neutral taken from a motor-generator balancer set.

The new motor generator consisted of a 2300-volt three-phase 60-cycle synchronous motor driving a 220-volt interpole compound-wound three-wire direct-current generator, with collector rings outside of the commutators to which the star-connected compensator for the neutral was connected.

The purchaser undoubtedly did not know and the builder did not mention the probable trouble ahead until the machine was installed and attempts were made to parallel it with the 220-volt compound units and balancer set. The result was so disastrous that the erector cut out the split series-field winding, making the machine a shunt interpole three-wire generator, with the result that it could not be made to carry its rated load even when all the shunt-field resistance was cut out and the brushes shifted to a point where destructive sparking occurred.

An expert, sent out by the manufacturing company to investigate the trouble, spent several days testing the machine and reported that it worked perfectly as a compound generator, and for the first time called the purchaser's attention to the fact that the other compound-wound machines to operate in parallel with the new one should have their series-field winding split and additional cables, switches and circuit-breakers would be necessary and additional busses would have



CONNECTIONS OF THREE-WIRE GENERATOR

to be installed. This meant considerable expense at a time when an effort was being made to change over to alternating current, and the matter was dropped with hard feelings all around, the machine being operated as a shunt machine under partial load until such time as enough of the direct-current load was connected to the alternating-current system for the motor-generator set to take care of the direct-current service. Then the series-field winding was connected back into circuit with a switch mounted in each terminal block, as shown at *S* in the figure, so that the series-field winding could be short-circuited whenever it was necessary to operate this machine with other direct-current units.

With the switches closed the machine operates as a direct-current shunt generator, and with the switches open the armature current passes through the compound winding, giving good voltage regulation and making the machine available for a full load.

The six heavy lines *A* and *A* in the figure show the main leads as it was intended to connect up the machine. *B* and *B* are positive and negative leads as run by the manufacturer's engineers, thus leaving the series-field winding cut out of circuit. The dotted lines *C* and *C* show positive and negative leads as now run to the switchboard, and the dotted section *d* and *d* shows the connection between the series-field and the interpole windings.

The Electrical Study Course—Losses in Direct-Current Machinery

The losses in direct-current machines are friction, excitation, armature-copper losses and core losses. These losses are discussed, and the method of determining the efficiency of a generator is given.

WHENEVER energy is changed from one form to another, there is always a loss in the transformation. For example, the amount of energy transmitted by the steam to the cylinder of an engine in the form of heat is not all available at the flywheel to do useful work. A large percentage of the energy actually supplied to the engine is lost in the exhaust, in radiation from the surface of the cylinder and in overcoming the friction of the moving parts, etc.

What has taken place in the engine is, the energy in the steam has been converted into a mechanical form of energy which may be used to do the mechanical work of driving any kind of machinery. If the engine is used to drive an electric generator, then we will have another transformation of energy; that is, the mechanical energy transmitted to the engine's shaft or flywheel will be converted into electrical energy and transmitted through the circuits to the devices supplied by the generator. In this transformation from a mechanical to electrical energy there is also a loss just as in the steam engine; that is, if the energy delivered to the engine's flywheel is capable of developing 100 hp., then less than 100 hp. will be delivered to the circuits. Part of the power developed at the engine shaft will be expended in overcoming the friction of the moving parts of the generator, exciting the field coils, the losses due to the resistance of the armature circuits and eddy-current and hysteresis losses.

The friction losses in a direct-current machine consist of the friction of the bearings, brushes on the commutator and the friction of the air upon the revolving element. The last item is usually known as the windage losses. The total friction losses amount to about 6 per cent. of the capacity of the machine for a 1-kw. unit to about 3 per cent. for a 1000-kw. unit. These may be considered as the mechanical losses of the machine; that is, they represent mechanical power that has been supplied to the generator and that has not been converted into electrical power, but has been expended in doing the mechanical work of overcoming the friction of the generator.

The current that is used to excite the field coils represents electrical power that has been generated in the armature, but is used up within the machine to energize the field coils, therefore is not available for doing work outside of the machine. The amount of power required to energize the field coils of direct-current machines is about 6 per cent. of the total output for machines of 1-kw. capacity to about 1.4 per cent. in 1000-kw. sizes.

Since the energy expended in the field rheostat is also charged up against field losses, the power loss in the shunt-field winding is practically constant, being only changed slightly by the hand adjustment of the rheostat. The losses in the shunt-field winding are therefore equal to the volts at the armature terminal times the current supplied to the field coils.

The energy expended in the field coils is sometimes referred to as the excitation losses or I^2R losses in the shunt-field winding; that is, the loss in the field coils is equal to the square of the current times the resistance of the field coils and that of the section of rheostat in series with the coils. For example, the total resistance of a shunt-field circuit is $R = 27.5$ ohms, and the voltage at the armature terminal is $E = 110$; then the current flowing in the field coils is $I = \frac{E}{R} = \frac{100}{27.5} = 4$ amperes, and the watts $W = EI = 110 \times 4 = 440$. The watts are also $W = I^2R = 4^2 \times 27.5 = 4 \times 4 \times 27.5 = 440$, which gives the same result as the former method.

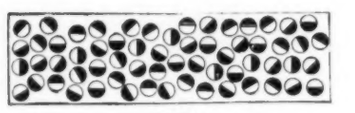


FIG. 1

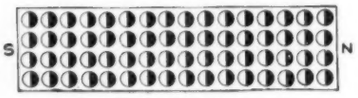


FIG 2

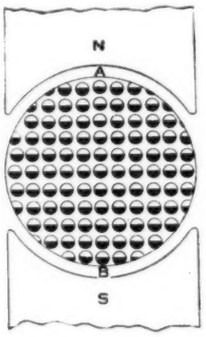


FIG. 3

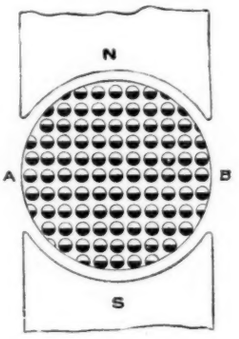


FIG. 4

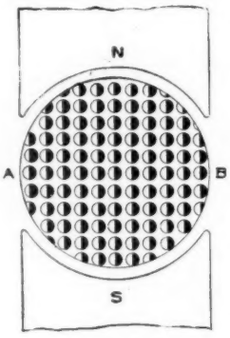


FIG. 5

FIGS. 1 TO 5. ILLUSTRATE HOW IRON MOLECULES ARE SUPPOSED TO ARRANGE THEMSELVES WHEN UNDER THE INFLUENCE OF A MAGNETIC FIELD

In the previous lesson we found out that a part of the voltage generated in the armature was used up in overcoming the resistance of the armature windings to the flow of the current. This also represents a loss of power supplied by the prime mover to the generator. This loss is usually called the armature copper loss, or I^2R loss, and is one of the chief factors in increasing the temperature of the machine. The power loss in the armature copper is equal to the voltage drop through the armature winding times the current supplied by the

armature; it is also equal to the square of the current times the resistance of the armature winding.

For example, the resistance on a given armature is $R = 0.1$ ohm, and the total current supplied to the load and shunt-field winding is $I = 150$ amperes; then the volts drop in the armature is $E_d = IR = 150 \times 0.1 = 15$ volts, and the watts loss in the armature is $W = E_dI = 15 \times 150 = 2250$ watts. The watts loss is also $W = I^2R = 150 \times 150 \times 0.1 = 2250$.

The losses in the armature copper vary from about 4 per cent. of the capacity of the machine in 1-kw. units to 1.8 per cent. for units of 1000-kw. capacity. These losses vary as the square of the current supplied by the armature and are practically zero at no load, being only those due to the shunt-field winding current, and at a maximum value at maximum load. The resistance of the armature circuit is usually considered as that of the armature windings, brushes, series-field windings if the machine is compound-wound, and the machine leads and terminals.

In the lesson on direct-current armature constructions in the Jan. 13, 1918, issue, it was shown that when the armature core is revolved between the polepieces, it cuts the lines of force and therefore generates a voltage the same as the windings do. It was also shown that the current caused to circulate around in the core by this voltage, or eddy current as it is called, created a pull that opposed the turning effort of the prime mover driving the generator, consequently represented a direct loss of power. The eddy-current losses are usually combined with the hysteresis losses and are called the iron or core losses.

The hysteresis losses are those which are due to the friction of the molecules, of the iron in the armature core, on each other as they align themselves with the lines of force when the armature is revolved. This is illustrated in Figs. 3 to 5. In the lesson "Elements of Magnetism—II," in the Jan. 30, 1917, issue, it was explained that a piece of iron acted as if each molecule was a magnet having a north and a south pole, and that under normal conditions the molecules arrange themselves so that the N and S poles of one molecule were neutralized by the N and S poles of other molecules and thus form a neutral condition, as in Fig. 1. When the piece of iron is brought under the pole of a magnet, this pole will attract the opposite pole of the molecules of the iron and cause them to be arranged in a systematic group, as in Fig. 2, thus producing a N pole at one end of the bar and a S pole at the other. In the same way, when the field poles of an electrical machine are magnetized, they cause the molecules in the armature core to arrange themselves systematically as in Fig. 3. Now if the armature core is turned 90 deg. from the position in Fig. 3, as in Fig. 4, it will be seen that although the core as a whole has revolved 90 deg. to the left as indicated by AB, the field magnets have held the molecules of the iron core in the same position in each case. For this to be possible the molecules have done what is equivalent to turning to the right 90 deg. If they had remained in a fixed position in the core, the condition that would exist is that in Fig. 5, from which it is seen that if each molecule turns 90 deg. to the right from the position in the figure, a condition exists in the core corresponding to that in Fig. 4. This is just what appears to be going on in the armature core all the time that it is revolving and the field poles are magnetized. As the armature revolves as a whole in one direction the molecules are revolving about their axis in the opposite direction. The molecules revolve at the same rate as the armature core in a two-pole machine, or one revolution for one pair of poles. The latter statement conforms to the condition existing in all multipolar machines; that is, the molecules make a complete revolution about their axis for each pair of poles in the machine. In a four-pole machine they would be revolving twice as fast as the armature, in a six-pole machine three times as fast, etc.

To cause the molecules to revolve about their axis requires a certain amount of power. The power that is expended in changing the position of the molecules is the hysteresis losses in the core. This, combined with the eddy-current losses, is called the core losses, and amounts to about 4 per cent. in machines of 1-kw. capacity to about 1.2 per cent. in 1000-kw. machines. If an attempt is made to turn the armature of an electrical machine by hand, with the field poles dead, it should turn very easily, but when the field poles are magnetized, it will be found that a greater effort must be developed to turn the armature. This increased effort required under the latter condition is due almost entirely to hysteresis, or in other words, to rotating the molecules of the core.

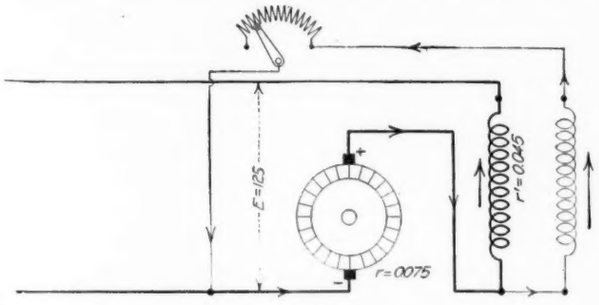


FIG. 6

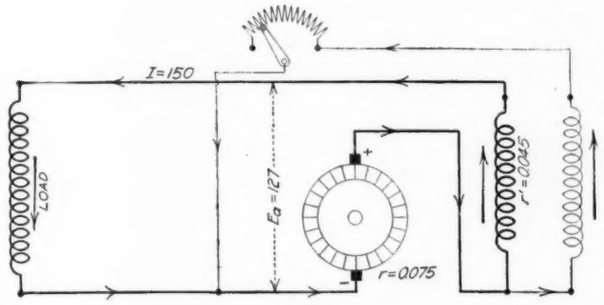


FIG. 7

FIGS. 6 AND 7. DIAGRAMS OF COMPOUND GENERATORS

The total losses at full load in a 1-kw. machine amount to about 20 per cent. of the output, while in the 1000-kw. machine they are about 4.5 to 5 per cent. In other words, when a 1-kw. machine is delivering its full-rated load (1-kw.) it will require about 1.2 kw. to drive it, and when a 1000-kw. machine is delivering its full rated load (1000 kw.) it will require about 1050 kw. to drive it.

The ratio of the output of a given machine to the input is called the efficiency and is usually expressed in a percentage, thus: Per cent. efficiency $= \frac{\text{output} \times 100}{\text{input}}$,

from which, output $= \frac{\text{input} \times \text{per cent. efficiency}}{100}$, and

input $= \frac{\text{output} \times 100}{\text{per cent. efficiency}}$.

For example, a given generator requires 50 hp. to drive it when supplying 32 kw. to a lighting system. Find the percentage of efficiency that the machine is operating at.

The input in this case is horsepower, kilowatt $= \frac{\text{hp.} \times 746}{1000} = \frac{50 \times 746}{1000} = 37.3$; then per cent. efficiency $= \frac{\text{output} \times 100}{\text{input}} = \frac{32 \times 100}{37.3} = 86$ per cent. approximately. That is, only 86 per cent. of the power supplied to the machine is available for doing useful work in the lighting system.

The problem given in the last lesson is shown in Figs. 6 and 7. The resistance of the armature and series-field winding is $R = r + r' = 0.075 + 0.045 = 0.12$ ohm. At no load the machine develops 125 volts. When the armature is supplying a current $I = 150$ amperes to an external circuit, as in Fig. 7, the volts drop through the armature and series-field winding is $E_d = RI = 0.12 \times 150 = 18$ volts. The load current flowing through the series-field winding was assumed to have caused the armature to generate 20 volts more than at no load, or a total $E = 125 + 20 = 145$ volts. The load current caused 18 volts drop, then the volts across the line terminals is $Ea = 145 - 18 = 127$, or an increase of $127 - 125 = 2$ volts.

A given shunt generator when supplying a constant load requires 175 hp. to drive it, and the voltage at the armature terminal under this condition is 115. The core losses of this machine amount to 4.5 hp., the field winding resistance is 11.5 ohms, the armature copper losses are 3500 watts, and to overcome the friction on the machine requires 1.5 hp. Find the percentage of efficiency at which the machine is operating.

Commutator Was Strained

By E. C. Parham

The general practice in tightening commutators is to heat them first so as to soften the insulation and thereby make it more yielding to the pressure; the resistance then offered to the tightening of the nuts gives an indication of how tight the construction is. One method of heating large commutators, after the machine has been installed, is to apply a number of gasoline torches around the periphery while the armature is kept rotating fast enough to prevent overheating in spots. Another method is to operate the machine with load and with the brushes shifted to a position that causes considerable sparking.

A large generator gave trouble by sparking at the brushes, which was attributed to loose commutator bars. According to the operator's statement, the commutator when the machine was installed was a little out of round, as indicated by the brushes riding up and down once per revolution. Slight eccentricity of the commutators of an engine-driven generator is not at all unusual, nor is it, as a rule, objectionable on this type of machines, and there are hundreds of machines operating satisfactorily in this condition. The commutator is finished in the shop after being installed on the armature, but even at that, when the armature is installed on the engine shaft the commutator frequently runs with a slight eccentricity which can best be removed by truing it up while the armature turns in its own bearing.

The operator in this case had tightened the commutator without heating it, and, to make sure that it was tight, applied all the pressure that three men could exert with a six-foot length of pipe on a wrench. The result of this treatment was that the commutator was so tight that the heat due to normal operations caused the commutator bars to bend out in the middle—this caused poor brush contact, and the sparking became worse than ever. By loosening the commutator, heating it and retightening, using the pressure of two men with a two-foot length of pipe on the wrench, and then grinding the surface with a stone, commutation became perfect although the commutator was still eccentric.

Blowoff Pipe Scaled

The engineer who has no trouble with scale in his boilers is a fortunate individual. The scale-forming salts in boiler-feed water, as is well known, coat the boiler shell and tube, frequently to such an extent that in the case of return-tubular boilers the tube ends

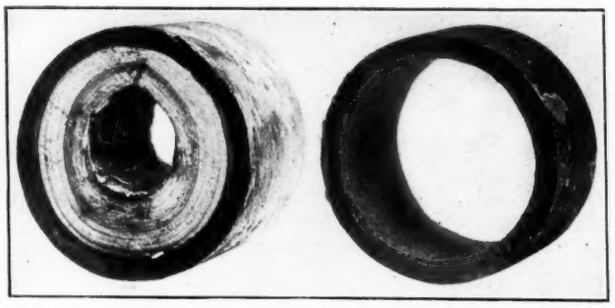


FIG. 1. SCALE IN HORIZONTAL PIPE

FIG. 2. SCALE IN THE VERTICAL PIPE

become burned and are prevented from leaking seriously only by the heavy deposits of scale around the tube and on the boiler heads. In water-tube boilers the scale problem is so serious in many localities that some of the tubes become practically stopped up with a hardened lime deposit.

The boiler blowoff pipe is not exempt from scale deposit, and sometimes the formation presents an interesting study. For instance, Fig. 1 shows a piece that was cut from the horizontal section of a blowoff pipe on a 72-in. boiler. This pipe had been in use for four years, and the boiler was, so far as known, blown down at least once each day. It is interesting to note the built-up layers of scale, as shown by the variation in colors. Although the inside diameter of the pipe is approximately $2\frac{1}{2}$ in., the opening through the scale is but $1\frac{3}{16}$ in. at its greatest diameter.

In Fig. 2 is shown a piece of the pipe that was cut out of the vertical section, and, as may be seen, the scale formation is but about $\frac{1}{16}$ in. thick, and evenly distributed at that. An interesting question is, Why did the horizontal pipe scale so much more than the vertical section?

Editorials

What Are You Doing With Your Coal?

THE United States must furnish 634,594,000 net tons of bituminous coal to feed the ever-increasing demand of the war machine for fuel and to keep the country warm during the present coal year. Estimates compiled by the Fuel Administration indicate an increased demand for 79,866,000 net tons of bituminous coal, which must be met either by an increased production or by conservation and limitation in the use of coal. To meet this demand in full by production would mean an increased output of 14.4 per cent. over the production for the year 1917, which amounted to 554,728,000 tons.

The estimates are based upon figures submitted by the various departments of the Government indicating their increased demands for fuel during the current year. In some cases the Fuel Administration has found it necessary to go directly to industrial consumers to ascertain the amount of their requirements. To secure an output of 634,594,000 tons during the coal year it would be necessary to maintain an average weekly production of more than twelve million tons. This amount has not been produced in any single week during the history of the bituminous-coal mining industry. The nearest approach to this requirement was reached during the week of May 25, when the week's production was estimated at 11,811,000 net tons.

The demands for sending ships from American ports on foreign service show the largest percentage of increase. The Shipping Board has estimated that to supply bunkers to ships in the foreign trade will require thirty per cent. more coal than in 1917. The industrial requirements of the country, augmented by the tremendous expansion of war manufactures, will demand eighteen per cent. more fuel during 1918 than during 1917. The public utilities of the country will need a fifteen per cent. increase, domestic consumers a thirteen per cent. increase and the railroads a seven per cent. increase over the requirements of last year.

In addition to these increases, new requirements for coal will demand an additional nine million tons. Two million tons of this are allotted as a substitute in the West for oil, which may not be available because of ocean transportation difficulties, and seven million tons will go to give an additional ten days' storage supply to the industrial concerns and public utilities outside of the New England States. The regular allotment to New England will provide for thirty days additional storage in those states.

There will be no increase in the amounts allowed for exports, for the manufacture of beehive coke or for bunkering domestic ships, including those on the Great Lakes.

The industrial consumption of coal will be about eighteen per cent. greater for this current year than it was last year. But this presupposes still greater economy in the use of coal than has even now been widely achieved. With the Fuel Administration classifying power plants and giving priority of coal to those that do all they can to economize, engineers must not cease but must increase their vigilance in and about the plant.

No engineer could do better than spend an hour with his chief, going over with him this classification plan of the Fuel Administration. The argument that the matter of power costs is insignificant compared with the cost of the product made at the mill or works no longer holds. Coal is essential, be its cost great or small. To get it in reasonable time a plant must show that it is using it economically. The plant management must *show*—not assert or promise or protest, but show—that it is using it efficiently. Our readers may be sure that the Fuel Administration means business. The coal-mine operators, particularly those of Pennsylvania, have been shown recently, and in a surprisingly forcible manner, that the Fuel Administration means business.

If you keep no account of the performance of your plant, particularly the boiler room, begin to do so immediately. Use as high-class scales and meters as you wish, but use something right away. A record of wheelbarrow or dump-cart or carloads of coal is better than no record at all; but such crude means should be temporary only. The time is here when the management must see the necessity of providing the right selection of meters, instruments and equipment for the plant. Having got them on the recommendation of the engineer, he expects that the engineer knows how best to use them and that he will so use them.

Fires in Turbo-Generators

THERE are numerous ways in which a turbo-generator may fail in service, and for periods of from a few seconds, where the steam end opens inadvertently owing to the overspeed device operating or a mistake on the part of the operator, to several weeks when the generator burns up and must be rewound. The steam end of a turbo-generator causes lesser delays, but more frequent ones than the electrical end. Worn bearings, stripped or eroded blades may be renewed in a few hours. With the electrical end it is usually a different matter, for the trouble, instead of being localized and readily get-at-able, is such as necessitates disturbing parts other than those affected, and much work in reaching them.

The larger the capacity of a machine the greater the dependence placed upon it; the greater the importance, therefore, of maintaining it in service and the more serious its failure. Precautions may be justified with large units that would not deserve consideration with smaller ones, nor would they be financially feasible.

Undoubtedly, the most serious accident that can be-

fall a turbo-generator, which is not only the most expensive to repair but also of the most protracted delay, is that of a burn-out. Rarely is but one coil alone damaged, but generally several. Often the core is damaged too, necessitating replacement. In any case taking out and replacing the damaged coils require that other coils also be removed in reaching those injured. As a matter of fact, many coils are usually damaged, if not by the actual short-circuit and accompanying arc, by bending and movement in the slots under the enormous magnetic stresses set up by the short-circuit current. When a generator short-circuits internally, a fire may follow, though not necessarily, and a sustained internal fire may cause a short-circuit, although the cause cannot always be easily determined after the event, since the consequence removes the cause in many cases.

A few years ago, when one of the leading central-station companies installed a large turbo-generator, an occurrence of world-wide interest at that time, the matter of internal fires and possible modes of protection were considered, it being felt by some that the chance of conflagration occurring was a very real one, accompanied by very extensive damage. However, at that time the ruling opinion was that the large modern turbo-generator contained nothing that would burn, and that such machines were amply protected. Since that time several serious fires have occurred in turbo-generators—one in the station already referred to—that resulted in extensive damage to the units involved, heavy expense for repairs and perhaps an even greater cost due to loss of capacity and operating smaller and less efficient machines.

The incidents cited in the discussion letter, "Fires in Turbo-Generators," on page 705 of May 14 issue, clearly indicate that the modern turbo-alternator is far from being fireproof, and if fires do occur they are rarely quenched before the windings are destroyed. Although experiments have been carried on recently, as pointed out on page 883 in this issue, to find out the best method of extinguishing fires in large generators and motors, this subject has not received the attention that it merits, as evidenced by the large number of machines that have been destroyed by fire, with no special means of extinguishing the fire at hand. This seems to be one feature in the design and operation of large electrical machines that, if given the proper attention, holds forth possibilities of greatly increasing the reliability of this class of equipment.

Duty of the Employer in Reconstruction of the Crippled Soldier

ALMSGIVING tends to make the recipient more dependent. On the other hand, if the same individual is provided the wherewithal to earn his own living and made to feel that he is earning it, he will be put in a fair way to achieve success and become an asset to the community. It is with this fact in mind that the American Red Cross has undertaken the reconstruction work for our crippled soldiers, thousands of whom will return from the battlefronts before the termination of the war. The employer's side of this work is clearly outlined in an article, "Duty of the Employer in the Reconstruction of the Crippled Soldier," by W. C. McMurtrie, on page 890 of this issue.

It is well known that our pension system, in so far as constructive ends are concerned, has been a failure. The pension did not provide sufficient means to support the disabled soldier in decency, and instead of arousing in the cripple a desire to help himself, it was an incentive to idleness and, not infrequently, worse. From the experience gained in foreign countries it has been demonstrated that the only sound method of dealing with the disabled soldier is to train him for a trade in which his physical disabilities do not incapacitate him. The work carried on in Europe has shown that it is practically possible to train every cripple in some class of work so as to make him an independent and useful citizen.

The problem of making not only the military cripple but also the industrial cripple useful should be considered, for we cannot afford to allow a healthy man to be a dependent on the nation when a little intelligent effort on the part of an employer might make him a productive worker and an independent citizen.

According to the plan under way in this country, the Government will provide the necessary medical treatment, supply artificial limbs, conduct the training for an occupation and find the job. It will, however, rest with the people whether they will encourage the soldier to accept the advantages of training which will refit him for a life of usefulness and self-respect. There is a general feeling that the nation should maintain the crippled soldier in idleness for the rest of his natural life. Nobody will deny that the disabled soldier is entitled to every consideration, but maintaining him in idleness or in a charity job is generally the last thing that tends toward maintaining him as a self-respecting citizen. As Mr. McMurtrie has pointed out,

> Too many employers are ready to give the crippled alms, but not willing to expend the thought necessary to place him in a suitable job. This attitude has helped to make many cripples dependent. With our new responsibilities to the men disabled in fighting for us, the point of view must certainly be changed. What some cripples have done other cripples can do if only given an even chance. If the employer will do the returned soldier the honor of offering him real employment rather than proffering him the ignominy of a charity job, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility.

Garabed Giragossian, who was going to pluck energy out of the vast unknown, has failed at this writing to exhibit an operating machine. He told the writer that he has had a machine in operation and has run it from eight o'clock in the evening until two in the morning continuously and many other times for shorter periods; that he can stop and start it any time at will and can demonstrate the practicability of his plan inside of a week after the appointment of the investigating committee. Come on, Garabed, step on the gas!

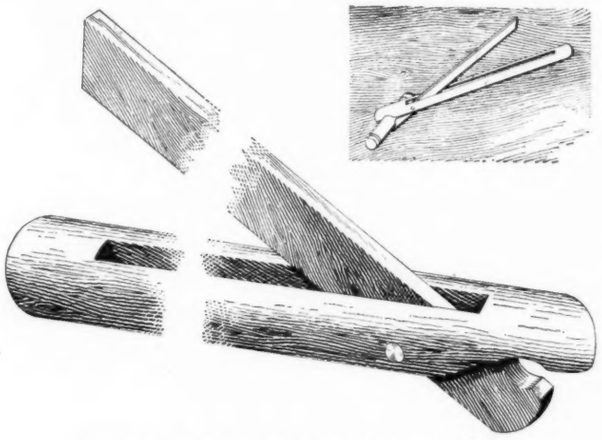
". . . We have added to the American flag since our war against Germany began, nearly 4,500,000 tons of shipping. We have today under contract and construction 819 shipbuilding ways including wood, steel and concrete, which is twice as many shipbuilding ways as there are in all the rest of the shipyards of the world combined."—*Chairman Hurley of the Shipping Board.*

Indeed the Yanks are coming!

Correspondence

Wooden Pliers for Replacing Fuses

The illustration shows a pair of wooden pliers handy for replacing blown-out high-voltage potential transformer fuses with safety to the operator. It is made of



HANDY PLIERS FOR REPLACING FUSES

an ordinary broom handle and a piece of 1 x ¼-in. hard maple. The broom handle is slotted to receive the maple piece. Anyone can make this tool, and will find it handy around the switchboard, especially with green help.

Hoosick Falls, N. Y. GEORGE DEWAR.

Burning Wood to Conserve Coal

It has been suggested frequently of late that we of the Southern States burn wood in order to conserve the supply of coal. I have been interested particularly in the descriptions of different methods of burning this fuel. I believe, to be conservative, that seven-tenths of the steam plants in the State of Florida are generating steam with wood as fuel. Aside from the larger plants the same proportion will hold true for the State of Georgia. Alabama, of course, is nearer to the coal fields and therefore burns more coal. There seems to be a general impression that wood fuel is plentiful in these three states, but many plants are burning slabs and strips because cord wood is either impossible to get or so expensive as to make it prohibitive, which would seem to indicate that wood is not so plentiful after all.

In my opinion it is just as criminal to waste a thousand B.t.u. in wood as in coal, and the present methods are most wasteful. The only economical way of burning wood or slabs, is to "hog" it, or grind it to ¾- or 1-in. size, store in an overhead storage bin and feed directly to boilers equipped with dutch ovens. In this way all the fuel received could be hogged, stored and burned as needed. The added economy resulting from an installation of this kind would be a closer regulation and a more uniform rate of combustion, as the fire-doors would not have to be opened so often, admitting large volumes of cold air, and less damage would be done to the boiler setting. A motor-driven chain conveyor could be used to deliver the hogged fuel to the firing floor or directly to the furnace.

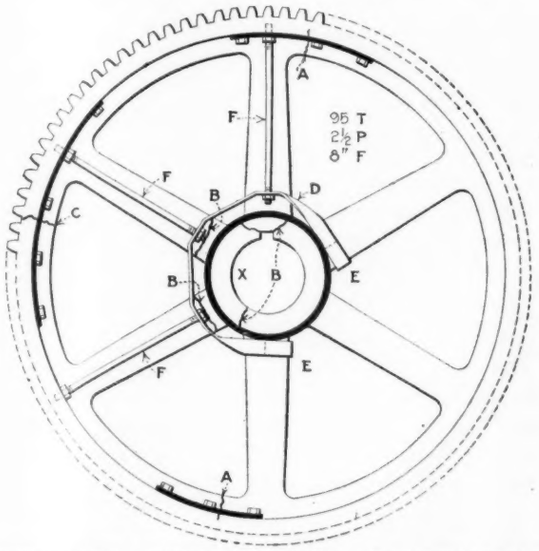
I would like to see more discussion on wood as fuel. Aside from the reasons why I should burn it, I am interested in any suggestions as to how I can use it to better advantage. W. WALTON CRANFORD.

Fort Myers, Fla.

Repairs to Broken Gear Wheel

The machine to which a large gear, broken as shown in the illustration, belongs should be in use every day, so when it broke it was up to the master mechanic to make quick repairs, for under present conditions the delivery of a new one or having the broken one welded would mean the loss of valuable time.

We found the web cracked through and the rim partly through at *A*. The hub and arms were broken through at *B* and the rim at *C*, and the gear was forced around on the shaft until the key was about at *X*. We drew the key and removed the wheel from the shaft, then drew the gear together with rods and bolts as closely as possible. Next, three rings were shrunk on the hub, two on one side and one on the other, and plates made to fit the inside of the rim, as shown by the heavy lines. These were drilled and put on with capscrews after the hub was drawn up by the bands. The arms were stif-



BROKEN GEAR WHEEL REPAIRED AND RETURNED TO SERVICE

fened by means of rods from the strap *D* hooked over two good arms and on the other side, where the hub was long enough to receive it, by a large band. The gear was then replaced, keyed up tight and the machine started, and it ran as well as ever. JOHN DRUMMOND.

Granby, Que., Canada.

Instruments Improve Plant Economy

In the plant in which the writer is chief engineer, two 372-hp. water-tube boilers equipped with chain-grate stokers were installed. One of first questions to arise was that of damper regulation. It was decided to control the dampers from the fronts of the boilers, using straight pieces of shafting and rocker-arms to complete the connection with a ratchet lever mounted at the side of the setting. This arrangement worked satisfactorily until a draft gage, a recording steam-pressure gage and a hand CO_2 outfit were purchased. The recording-pressure gage began to tell tales. Fig. 1 will give an indication of what was happening. The firemen would allow the steam pressure to drop 10 or 15 lb., then open up the feed on the stokers so that a large quantity of green coal was fed onto the grates. They would also open up the damper and allow a rush of cold air into the furnace, lowering the temperature of the combustion chamber as well as carrying 50 per cent. of the volatile gases up the chimney unburned.

Instructing the firemen to continue to operate the boilers as they had in the past, I connected up the CO_2 analyzer and took a reading when the combustion was good and the steam pressure normal. The result was 12 per cent. CO_2. When the steam pressure began to drop, the fireman as usual, proceeded to admit a large quantity of green coal and open up the damper. A sample of gas showed only 5 per cent. CO_2. Evidently a change in firing methods was in order to stop the fluctuation in pressure, and it was apparent that the draft was not regulated as it should be.

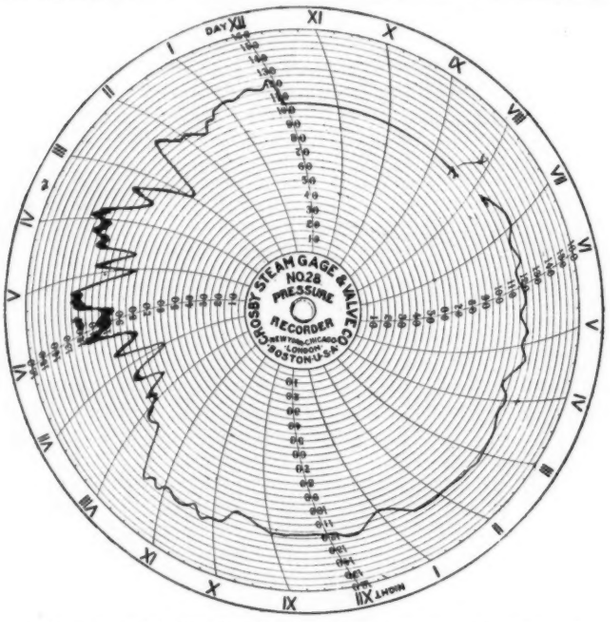


FIG. 1. PRESSURE CHART BEFORE PURCHASE OF INSTRUMENTS

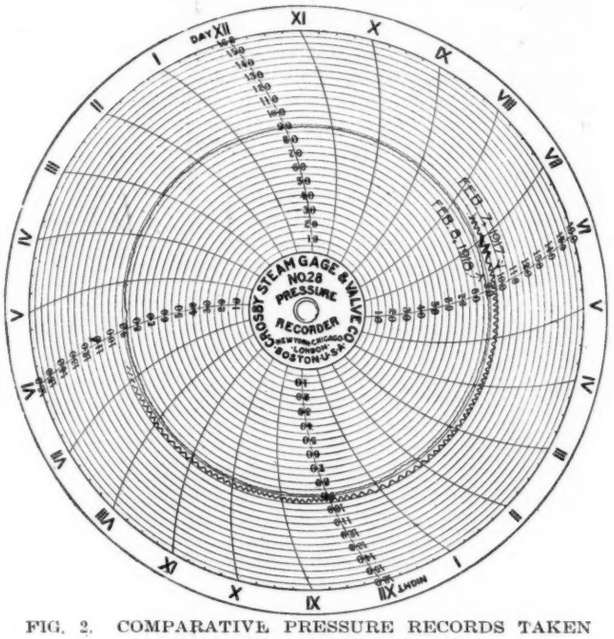


FIG. 2. COMPARATIVE PRESSURE RECORDS TAKEN FEB. 7, 1917, AND FEB. 8, 1918

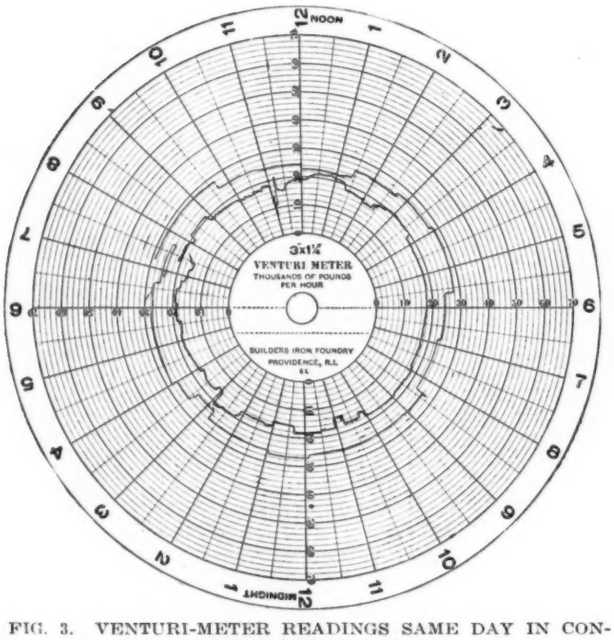


FIG. 3. VENTURI-METER READINGS SAME DAY IN CONSECUTIVE YEARS

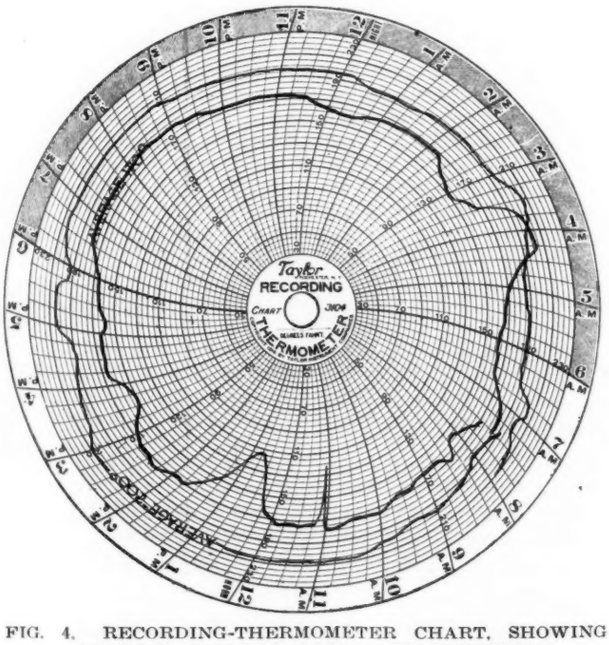


FIG. 4. RECORDING-THERMOMETER CHART, SHOWING INCREASE IN FEED-WATER TEMPERATURE

A damper regulator was purchased and this instrument worked to perfection. Still there was not proper control of the stoker engine. This difficulty was overcome by taking off the governor, putting a ¼-in. bypass around the main throttle and opening the valve just enough to keep the engine turning over. An arm from the damper-regulator shaft was then connected to the throttle valve, and the regulator was set to operate at a small variation in pressure. The outer circle in Fig. 2 shows the result of the first attempt, and the inner circle indicates what is now being done in the plant. The variation in steam pressure is very small and the CO_2 seldom goes below 11 per cent.

It is worthy of mention that the recording charts are being conserved by using them from year to year on corresponding days by changing the color of the ink. The records shown in Fig. 2 were taken on Feb. 7, 1917, and Feb. 8, 1918. The plan is not so much to conserve the paper charts as to create comparative records of corresponding days in two or more years, depending upon the number of times the charts are used. This is a great help in operating the plant at high efficiency. Take for example the venturi-meter chart in Fig. 3. It shows how much the load has increased in a year's time, and Fig. 4, a chart from the recording thermometer, indicates the relative feed-water temperatures. The last-named instrument is a great improvement over putting your hand on the discharge pipe of the boiler-feed pump to learn the temperature of the water. Besides, it helps to locate any trouble that may develop in the pump. When the latter begins to give trouble, it is not always easy to tell whether the water is too hot or whether the pump is airbound. With a thermometer there is no difficulty in making the proper decision.

In the plant under discussion the use of a recording thermometer resulted in a considerable saving in coal. It was impossible to get the feed-water temperature above 170 deg. If it could be raised to 200 deg., calculation showed that a saving of $1.83 per day in coal could be effected. The trouble was in the location of the feed-water heater. It had been placed on a dead end from the exhaust heating line, so that there was no circulation through it, and the only way to remove the air was to open the roof valve, which of course was a waste of heat. Remodeling the piping connections so that all the exhaust steam passed through the heater on its way to the heating system made a feed-water temperature of 200 deg. possible, and as shown in Fig. 4, this temperature has been exceeded. J. J. SPANGLER.

Mooseheart, Ill.

Operated Turbine with Stripped Blading

I have read with interest some of the articles in *Power* regarding steam-turbine accidents and I wish to relate an experience due to losing six rows of the low-stage blading on a 500-kw. unit in the plant in which I am employed. The accident occurred with about 40 per cent. load on the turbine just after the generator had been synchronized with another unit and at the time the attendant was building up the vacuum on the condenser.

I was not at the plant when the accident occurred, but arrived about fifteen minutes afterward, and from evidence and from information gathered from the operating engineer I am of the opinion that the stripping of the blading was caused by water being forced up into the low-pressure end of the turbine by the priming pump after the circulating pump had stopped owing to a blown fuse on the motor drive, a jet type of condenser being used.

After removing the stripped and distorted blading from the cylinder and spindle, we put the turbine back in service and operated it for several months before renewing the low-stage blading, being able to pull the full rated capacity of the generator, although at a considerable increase in steam consumption. HOMER I. REEDER.

Emporia, Kan.

Fires in Turbo-Generators

The article "Fires in Turbo-Generators," by M. A. Walker, appearing in the Jan. 22 issue of *Power*, and the letter by Everett Palmer in the May 14 issue commenting upon this article, show conclusively that the problem of extinguishing fires in turbo-generators is one that should cause every power-plant operator serious concern. The number of turbo-generators in this country that have been completely destroyed by fire and that might have been saved with only the loss of one or two coils had the proper facilities been provided to take care of such emergencies, should make both operators and manufacturers consider such protection seriously. These fires have cost thousands of dollars for repairs, and even larger sums due to the long period required to make the repairs, which in many cases require practically rebuilding the whole core and winding of the generator. At first it was thought that the high-voltage turbo-alternator did not contain much that could burn, but today we know by many experiences that short-circuits in these machines will not only cause the insulation to be destroyed, but will also destroy the winding and core themselves.

Recently, a series of experiments was conducted by the General Electric Co., as reported in the January, 1918, issue of the *General Electric Review*, as to the best means of extinguishing fires in high-speed totally inclosed motors and turbo-generators. As a result of these experiments the conclusion was reached that steam, if supplied in sufficient quantities, will put out any fire that may occur by burning insulation; further, that the insulation, if properly dried out after a steam bath, will not be materially damaged. This method has the further advantage of relieving the boilers of some of their steam when practically the whole load of the unit is suddenly thrown off.

Carbon tetrachloride, while not as effective as steam, will put out such fires if used in sufficient quantities. It has the disadvantage, however, that it will attack and destroy the insulation; furthermore, its fumes are very injurious when breathed.

Carbon dioxide seems to be equally effective in putting out these fires, but it is hard to apply. It has to be kept in containers under high pressure, and there are instances where, when these gases were released, the outlet nozzles were quickly frozen up, owing to the refrigerating action.

As pointed out by Mr. Walker and Mr. Palmer, it is necessary that the machine be made dead and disconnected from the line immediately when the trouble

occurs, which can probably be best accomplished automatically, after which the steam should be turned on as soon as possible.

Another feature is the ventilating air. This must be cut off and the dampers at both intake and discharge must be closed, for the admission of large quantities of air will have a very marked effect in causing the fire to spread. In my opinion steam is far superior to water for putting out these fires, not only by reason of the advantages already pointed out, but alsc because the use of water is attended with some uncertainty as regards both its application and its effect on the rotating parts. Steam readily penetrates to all parts of the windings and will readily reach a fire in any remote part of the windings, where it might be impossible to reach it with water unless a considerable quantity is used. B. A. BRIGGS.

New York City.

Analyses of No. 2 Buckwheat Coal

In the May 21 issue of *Power*, page 728, under the title, "Coals of the United States," are given the proximate analyses of a number of coals from representative districts, the authority being Bureau of Mines Bulletin No. 22.

In the coals listed only one analysis of an anthracite is given. This is reported as being from an anthracite culm, but the results of this one analysis are so good compared with the anthracite received at the plant where I am employed that I ask you to give the inclosed analyses room in your publication so that others may see that all anthracite steam fuel is not as good as the article referred to would indicate. These analyses have not been chosen, but are the consecutive results of occasional samples taken and analyzed by a capable chemist.

PROXIMATE ANALYSES OF ANTHRACITE NO. 2 BUCKWHEAT (RICE) COAL

Date Car Unloaded	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.	Coal Received From
	—Per Cent. of Dry Coal—					
Dec. 29, 1917	4.10	72.85	23.05	....	.....	Mine A
Dec. 29, 1917	4.85	75.90	19.25	....	.....	Mine B
Jan. 1, 1918*	4.05	62.60	33.35	....	.....	Boiler room H
Jan. 1, 1918*	4.30	66.35	29.35	....	.....	Boiler room S
Jan. 3, 1918*	4.05	76.50	19.45	....	.....	Boiler room H
Jan. 3, 1918*	4.95	69.95	25.10	....	.....	Boiler room S
Mar. 1, 1918	5.70	71.00	23.30	....	.....	Mine B
Mar. 1, 1918	5.70	66.70	27.60	....	.....	Mine B
Mar. 11, 1918*	7.00	73.10	19.90	....	.....	Boiler room S
Apr. 11, 1918	6.40	73.20	20.40	....	.....	Mine C
Apr. 11, 1918	6.60	75.00	18.40	....	.....	Mine B
Apr. 16, 1918	6.50	70.50	23.00	....	.....	Mine A
Apr. 16, 1918	6.70	72.70	20.60	....	.....	Mine A
Apr. 20, 1918	8.00	74.30	17.70	0.65	11,399	Mine C
Apr. 20, 1918	5.90	75.50	18.60	0.85	11,379	Mine A
Apr. 25, 1918	7.40	68.40	24.20	0.62	10,208	Mine D
Apr. 25, 1918	5.65	69.55	24.80	0.68	10,352	Mine B
May 3, 1918	5.35	74.85	19.80	0.92	11,358	Mine A
May 3, 1918	5.40	77.30	17.30	0.78	11,557	Mine A
May 8, 1918	6.80	71.80	21.40	0.82	11,169	Mine B
May 8, 1918	6.10	66.50	27.40	0.90	10,173	Mine B
May 16, 1918	6.85	72.55	20.60	0.76	11,370	Mine B
May 16, 1918	6.80	74.90	18.30	0.68	11,612	Mine B

* Samples were taken from the supply in the boiler rooms.

Anthracite culm is generally understood to be inferior to No. 2 buckwheat (rice). We are now using about 8000 tons of this No. 2 buckwheat per month, and if we could have the analysis equal that given in the Government bulletin quoted by you, we could do with about seven or eight less cars per month based on the reduction of ash only, not considering the increased efficiency of boiler operation with the better fuel.

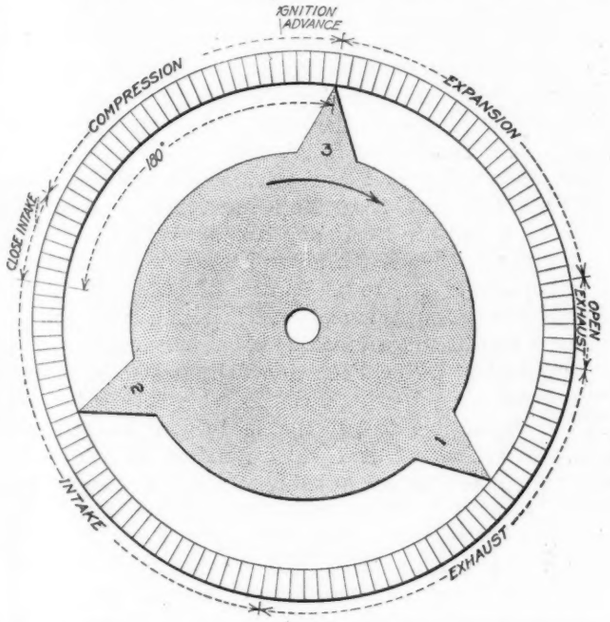
Pottsville, Penn. W. W. PETTIBONE

Gas-Engine Cycle Indicator

The figure shows a diagram of a cycle indicator for a three-cylinder four-stroke-cycle internal-combustion engine which I designed. To engineers familiar with the cycle the indicator is self-explanatory. The circular scale represents the four strokes of the cycle, or two revolutions of the crankshaft and one revolution of the camshaft. The pointers 1, 2 and 3 on the rotating member represent the cylinders and their working parts.

The pointers are numbered in the firing order of the cylinders, and the center piece must always contain as many pointers as there are cylinders in the engine. The center portion may also be made round and of the diameter of the inner circle of the scale, and in place of the pointers lines may be drawn and numbered accordingly. No matter how many cylinders there may be in the engine, the pointers will always show the relative positions of the vital working parts.

The indicator may be used for practical and educational purposes. If geared to the engine so that the



FOUR-STROKE-CYCLE, INTERNAL-COMBUSTION ENGINE CYCLE INDICATOR

center portion revolves at camshaft speed, the engineer can tell at a glance how the engine stands and what adjustments must be made, and by turning the engine two revolutions every valve and igniter can be set.

In looking at the diagram, No. 3 piston stands at top dead-center for ignition, No. 1 and 2 show the position during exhaust and intake respectively. Turning the engine a little farther, No. 2 intake closes with about 36 deg. delay at the lower end of the stroke. A little farther turning closes No. 1 exhaust at the upper end of the stroke. For demonstration purposes the indicator may be used as a hand instrument.

Pittsburgh, Penn. JOHN FETZER.

Surplus electric power produced by the Stimson Mill Co. at Ballard, Wash., by the burning of waste material will be sold to the City of Seattle at 0.004c. per kw.-hr. The mill company agrees to deliver to the city 1300 kw. for 12 hours and 300 kw. for the other 12 hours of the day.

Inquiries of General Interest

Advantages of Throttling Wet Steam—How is the operation of an engine improved by partly closing the throttle when the supply of steam is from a boiler that is priming? D. W. J.

By partly closing the throttle the process of wiredrawing the steam reduces its pressure, and the heat contained in the initial wet steam is sufficient to convert the mixture into dry steam at the reduced pressure, with the advantages of removing danger of a smash of the cylinder from presence of a large amount of water and of obtaining work of expansion from a larger proportion of the boiler output.

Radial Valve Gear—What is meant by the term radial valve gear? R. G.

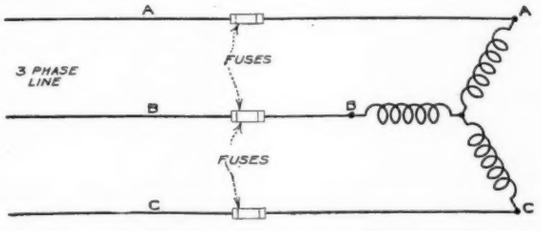
The name radial valve gear has been applied to a number of reversing gears that are quite different in design but agree in deriving the mid-gear motion of the valve from a source that is equivalent to an eccentric with 90 deg. advance combined with another motion that is equivalent to that of an eccentric with no angular advance. The general principle of operation of radial gears is that of obtaining from some reciprocating or revolving piece of the engine, an arrangement of radius bar and link work, a point in which shall describe an oval curve, and by altering the direction of the axes of this curve to produce a valve motion adapted to variable cutoff, reversal or stoppage of the engine.

Diameters of Mating Cone Pulleys—With stepped or cone pulleys used for belt transmission at variable speeds, should the sum of diameters of corresponding drivers and followers be constant for a constant length of belt? F. W.

When the belt is run crossed, a constant length of belt will be required for a constant sum of diameters, but for an open belt of constant length, the sum of diameters of mating steps cannot be constant because there is a changing belt angle to alter the length of belt required. The discrepancy is not perceptible for ordinary lengths of open belts required for countershafts, but for such cases as foot-lathe drives and speed cones, where the cones are closer together and there is a wide difference of diameters, the sum of diameters must be varied to compensate the varying belt angle.

Fuse Blown on 3-Phase Circuit—If one fuse blows on a 3-phase line supplying a 3-phase motor, will the motor be operating 2-phase or single-phase? N. E. A.

If one fuse blows on a 3-phase line that is supplying a 3-phase motor, the motor will then be operating single-phase.



Consider the three lines *A*, *B*, and *C* of the 3-phase circuit in the figure, one phase from *A* to *B*, another from *B* to *C*, and the third from *C* to *A*. Then if the fuse blows in line *A*, the phases from *A* to *B* and *C* to *A* are dead, the one from *B* to *C* being the only one that is alive.

Water Handled by Pump—What quantity of water would be handled by a 14-in. x 36-in. duplex pump making 12 revolutions per minute? J. D.

Neglecting the reduction of cross-sectional area of plungers or water cylinders due to piston rods, the displacement per stroke would be $14 \times 14 \times 0.7854 \times 36 = 5541.78$ cu.in. There would be four single strokes per revolution and with 12 revolutions per minute the total plunger or piston displacement would be $12 \times 4 \times 5541.78 = 266{,}005$ cu.in. or $266{,}005 \div 231 = 1151.5$ gal. per min. The actual discharge will depend on the amount of slip or reduction of the amount of water actually handled, due to defective piston packing, leaky stuffing-boxes or valves, the delayed closing of the valves and the amount of air carried into the pump body by the water. For a pump of this size and speed in good condition and working at moderate pressure, the slip should not exceeed 2 per cent., and the amount of water handled should be 98 per cent. of 1121.5 = 1128.5 gal per min.

Conversion of Vacuum Readings to Standard Barometer—If a mercury vacuum-gage reading is 26.5 in. at a temperature of 80 deg. F., with the barometer reading 29.3 in. at a temperature 70 deg. F., what would be the equivalent vacuum with 30 in. barometer at 62 deg. F.? G. A. W.

For practical purposes, and within moderate differences of temperature and barometer, the equivalent vacuum would give the same variation from the barometer; that is, 26.5 in. vacuum with 29.3 barometer might be considered to be equivalent to 30 — (29.3 — 26.5) = 27.2 in. vacuum with 30 in. barometer. When temperatures are considered the coefficient of expansion of mercury may be taken as 0.0001 per degree on the Fahrenheit scale and 26.5 in. of the vacuum gage would be equivalent to $26.5 - [26.5 \times (80 - 62) \times 0.0001] = 26.4523$ in. at 62 deg. F., and the actual barometer reading of 29.3 in. at the temperature of 70 deg. F. would be equivalent to $29.3 - [29.3 \times (70 - 62) \times 0.0001] = 29.27656$ in. at 62 deg. F. Therefore the unbalanced pressure would be 29.27656 — 26.4523 = 2.82426 in. of mercury at 62 deg. F. and used for 30 in. barometer at 62 deg. F. this would be 30 — 2.82426 = 27.17574 in. vacuum.

Estimating Height of Suction Lift—When a pump operates with a suction lift, how can a vacuum gage inserted in the suction pipe at the pump show the height of the pump above the water supply? W. G. S.

Water is forced up in a pump suction pipe by the pressure of the atmosphere acting on the surface of the suction water with sufficient pressure to overcome the inertia and friction of the water entering and moving along the pipe, plus the pressure due to the height of the suction lift, plus the pressure acting on the water at the pump. When a pump moves only just fast enough to keep the water in motion, there will be little pressure lost in overcoming friction and inertia and the atmospheric pressure will have to overcome little more than the pressure due to the height or head of water plus the pressure not removed by the pump.

A vacuum gage connected with the suction pipe at the pump will show how much lower than atmospheric pressure the pump has reduced the pressure at that point and each "inch of vacuum" will represent 0.491 lb. per sq.in. less than the pressure of the atmosphere. A vacuum gage placed at the level of the suction water would indicate 0 inches of vacuum, because the pressure would be equal to the pressure of the atmosphere. When no part of the atmospheric pressure is employed for overcoming friction or inertia of the water (as would be practically the case when a pump is running only just fast enough to "hold suction") then the pressure created by the head of water in the suction pipe would be equal to atmospheric pressure less 0.491 times the "inches of vacuum" at the pump, because the sum of these pressures would balance the pressure of the atmosphere. Atmospheric pressure may ordinarily be taken as equal to 14.7 lb. per sq.in. and, as one foot head of water makes a pressure of 0.433 lb. per sq.in., the height of "suction lift" in feet would be [14.7 — (inches of vacuum at pump × 0.491)] ÷ 0.433.

[Correspondents sending us inquiries should sign their communications with full names and addresses.—Editor.]

Spring Meeting AMERICAN SOCIETY of MECHANICAL ENGINEERS

THE semiannual meeting of the American Society of Mechanical Engineers, held at Worcester, Mass., June 4-7, was the largest spring meeting in the history of the society, the registration reaching one thousand. The opening session was held in the ballroom of the Hotel Bancroft on Tuesday evening. R. Sanford Riley, president of the Worcester Chamber of Commerce and a member of the society, greeted the visitors and introduced His Honor, Pehr G. Holmes, mayor of Worcester, who welcomed them to the city. President Charles T. Main acknowledged the welcome in a few well-chosen words, and Charles G. Washburn delivered an address upon "The Growth of an Industrial City." This was followed by a reception at the Worcester Art Museum, after which dancing and refreshments were enjoyed in the nearby Tuckerman Hall.

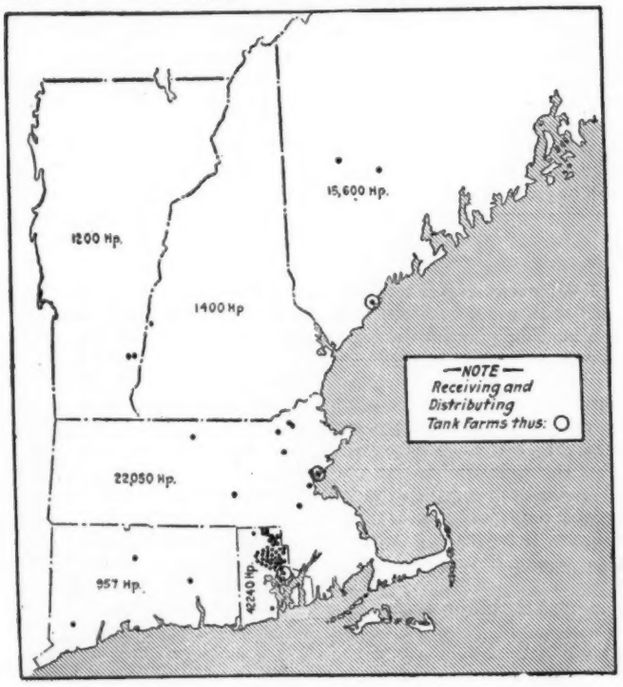


FIG. 1. LOCATION OF OIL-BURNING PLANTS IN NEW ENGLAND

Wednesday forenoon was devoted to a business session in the gymnasium of the Worcester Polytechnic Institute, at which constitutional amendments dealing with the procedure of nominating the officers of the society were considered, and the reports of committees on Screw-Thread Tolerances, Weights and Measures, and Steel Roller Chains were received. Worcester R. Warner delivered an address eulogistic of Past President and Honorary Secretary Frederick Remsen Hutton, and George H. Haynes presented a paper on "The Small Industry in a Democracy." Past President Ira N. Hollis made a plea for consecration to the task of winning the war.

In the afternoon three simultaneous sessions were held in various halls of the Polytechnic Institute. Many of the papers dealt with munitions and other war subjects. That of particular interest to *Power* readers,

Oil Fuel in New England Power Plants

by Henry W. Ballou, said that oil fuel was now in use in at least 60 power plants in New England having a total of some 83,000 hp. and in about 100 low-pressure steam plants for supplying heating systems. A list of the power plants and a map of their locations, Fig. 1, are given:

OIL-BURNING POWER PLANTS IN NEW ENGLAND

Plant	Type, Number and Hp. of Boilers	Total Hp.	Year	Oil-storage Capacity, Gal.
International Paper Co., Livermore Falls, Me.	B. & W., 6 (350), 10 (600)	8100	1915	300,000
International Paper Co., Rumford Falls, Me.	B. & W., 12 (600)	7200	1915	300,000
Jenckes Spinning Co., No. 1, Pawtucket, R. I.	B. & W., 3 (400), 1 (250)	1450	1915	50,000
Jenckes Spinning Co., No. 2, Pawtucket, R. I.	B. & W., 4 (400)	1600	1917	46,000
American Woolen Co., Riverside Mills, Providence, R. I.	Manning, 20 (200)	4000	1915	16,000
American Woolen Co., Bay State Mills, Lowell, Mass.	H. R. T., *4(150); Manning, 1 (200)	800	1915	50,000
American Woolen Co., Wood Mill, Lawrence, Mass.	H. R. T., 44 (200)	8800	1918	Concrete, 500,000
American Woolen Co., Washington Mill, Lawrence, Mass.	H. R. T., 3 (300); Heine, 4 (275); 11 (300); Gunboat, 4 (600)	7700	1918	125,000
International Braid Co., Elmwood Mill, Providence, R. I.	B. & W., 2 (150), 1 (250)	550	1915	35,000
International Braid Co., Fletcher Mill, Providence, R. I.	Manning, 7 (175)	1225	1916	25,000
Atlantic Mills, Providence, R. I.	Manning, 7 (175)	1225	1916	50,000
Manville Company, Manville, R. I.	H. R. T., 10 (150); B. & W., 3 (250)	2250	1916	125,000; (165,000 being added)
Manville Company, Bernon Mill, Georgiaville, R. I.	H. R. T., 4 (150)	600	1916	50,000
Manville Company, Nourse Mill, Woonsocket, R. I.	B. & W., 4 (250)	1000	1917	150,000
Manville Company, Social Mill, Woonsocket, R. I.	H. R. T., 16 (150)	2400	1917	320,000
Manville Company, Globe Mill, Woonsocket, R. I.	Manning, 7 (175)	1225	1917	70,000
Jos. Benns & Sons, Greystone, R. I.	Manning, 5 (175), 1 (125); Stirling, 1 (300), 3 (275)	2125	1916	190,000
Rhode Island Hospital, Providence,	B. & W., 1 (250), 1 (175), 2 (150)	725	1916	25,000
Rhode Island School of Design, Providence, R. I.	Keeler, 2 (250)	500	1916	7,000
Sayles Memorial Hospital, Pawtucket, R. I.	H. R T., 1 (200), 2 (50)	300	1916	22,000
Mexican Petroleum Corp., Portland, Me.	H. R. T., 2 (150)	300	1915	8,505,000
Mexican Petroleum Corp., Allens' Avenue, Providence, R. I.	H. R. T., 2 (75)	150	1915	3,885,000
Mexican Petroleum Corp., Kettle Point, East Providence, R. I.	H. R. T., 2 (175)	350	1917	6,930,000
Peace Dale Mfg. Co., Peace Dale, R. I.	B. & W., 4 (250)	1000	1916	50,000
Gorham Manufacturing Co., Providence, R. I.	Stirling, 4 (250)	1000	1915	50,000
Fitzgerald Building, Providence, R. I.	Manning, 2 (150)	300	1916	6,500
Shepard Company, Providence, R. I.	H. R. T., 2 (150)	300	1916	7,500
Newman Hotel, Providence, R. I.	H. R. T., 2 (75)	150	1916	4,000
Boston Store, Providence, R. I.	Scotch marine, 3 (105)	315	1916	11,000
Lonsdale Bleachery, Lonsdale, R. I.	B. & W., 10 (350)	3500	1917	Concrete 130,000
Royal Weaving Co., Pawtucket, R. I.	B. & W., 6 (350)	2100	1917	75,000

*Horizontal return-tubular

OIL-BURNING POWER PLANTS IN NEW ENGLAND—Concluded

Plant	Type, Number and Hp. of Boilers	Total Hp.	Year	Oil-storage Capacity, Gal.
Lorraine Mfg. Co., Pawtucket, R. I....	Manning, 4 (300), 9 (175)	2775	1916 and 1917	90,000
Grant Mills, Providence, R. I.....	Manning, 4 (150), 1 (200)	800	1916	20,000
J. D. Lewis Dye Works, Providence, R. I.....	H. R. T., 2 (150); Manning, 1 (150)	450	1915	8,000
Revere Rubber Co., Providence, R. I.	Edge Moor, 2 (250), 1 (500); Aultman-Taylor, 1 (500); Manning, 4 (175)	2200	1917 1917 1918	135,000 ....
Slater Yarn Co., Pawtucket, R. I.....	Stirling, 3 (250), 1 (175)	925	1917	46,000
Grant Yarn Co., Fitchburg, Mass....	Manning, 7 (150)	1050	1917	40,000
Providence Journal Co., Providence, R. I.....	B. & W., 3 (250)	750	1917	6,000
River Spinning Co., Woonsocket, R.I.	H. R. T., 2 (150), 1 (300)	600	1917	4,600
Mexican Petroleum Corp., Chelsea, Mass.....	H. R. T., 2 (175)	350	1917	9,240,000
Gerald Cooper, Providence, R. I.....	H. R. T., 1 (75); Manning, 1 (175)	250	1915 1918	25,000 .....
Merrimac Chemical Co., South Wilmington, Mass.....	H. R. T., 1 (300)	300	1917	8,000
Merrimac Chemical Co., Everett, Mass.....	B. & W., 3 (250)	750	1918	.....
The Thomas G. Plant Co., Boston, Mass.....	B. & W., 3 (250)	750	1918	70,000
Dimond Store, Providence, R. I.....	H. R. T., 3 (150)	450	1917	Concrete 7,000
Waite-Thresher Building, Providence, R. I.....	Scotch marine, 2 (200)	400	1917	Concrete 7,000
Union Hand Laundry, Providence, R. I.....	H. R. T., 1 (100)	100	1918	Unknown
Louttit Home Hand Laundry Co., Providence, R. I.....	H. R. T., 1 (150)	150	1917	Unknown
What Cheer Laundry, Providence, R. I.....	H. R. T., 2 (150)	300	1916	16,000
Springdale Finishing Co., Canton, Mass.....	B. & W., 2 (400)	800	1917	46,000
Anco Mills, Wilkinsonville, Mass.....	H. R. T., 5 (150)	750	1918	46,000
Versailles Sanitary Fibre Co., Versailles, Conn.....	Manning, 2 (150)	300	1918	3,000 Kerosene
Jones & Lamson Machine Co., Springfield, Vt.....	Stirling, 3 (250)	750	1916	25,000
Jones & Lamson Machine Co., Springfield, Vt.....	H. R. T., 1 (300), 1 (150)	450	1917	20,000
Claremont Paper Co., Claremont, N. H.....	Manning, 4 (300), 1 (200)	1400	1918	215,000
Robinson Bleach & Dye Works, New Milford, Conn.....	H. R. T., 3 (219)	657	1917	Unknown
Young Bros. Box Shop, Providence, R. I.....	H. R. T., 1 (100)	100	1917	3,500
Woodlawn Finishing Co., Pawtucket, R. I.....	H. R. T., 2 (75)	150	1917	23,500
Hennessey Laundry, Providence, R. I.	H. R. T., 2 (125)	250	1916	5,000
D. Goff & Sons, Pawtucket, R. I.....	H. R. T., 5 (250)	1250	1915	10,000

About one-half of the boiler horsepower served by oil is in Rhode Island. An outline drawing, Fig. 2, shows a typical power-plant equipment. Insurance requirements have ceased to be burdensome. No difficulty is experienced in pumping oil as warm as 130 deg. F. with a 10-ft. lift. About nine-tenths of these fuel-oil installations are substitutes for coal in existing plants. There is no other method of increasing the capacity of a boiler plant so quickly and cheaply as by substituting oil for fuel. In a number of cases the change to oil has made it possible to shut down one or more boilers. The simplicity and automatic action of oil meters as compared with the cumbersome methods of weighing coal are appreciated, and the keeping of power-plant records is simplified. A few plants have accomplished automatic regulation of the oil feed, but hand control is almost universal. It is inspiring to contemplate the probability that automatic regulation of the oil, the atomizing steam and the draft pressure will become a standard reality within a few years. The saving of labor due to oil firing as compared with coal has been given an exaggerated importance. Other than fixed charges, 80 to 90 per cent. of the boiler-room costs are in fuel, leaving little to be saved in labor. Crude petroleum may be divided into two classes—that with a paraffin base and that with an asphalt base. The first is so valuable for its derivatives that its price will always be prohibitive for fuel. The extremely heavy grades of asphalt-base oils from Mexico are practically the only fuel oils now available to New England. The present rapid increase in their use is but a lucky incident in the marketing of a great natural product. Immense as is its absolute volume, the insignificance of its relative volume as a source of world-wide fuel has thus far been the main obstacle to the adoption of Mexican fuel oil on the high seas. That obstacle is rapidly disappearing and, regrettable though it be, it is inevitable that its very virtues for this purpose will ultimately deprive the power plants of New England of fuel oil.

A commander of the Navy questioned a statement in the paper that the fireman could indulge in naps when fuel oil was used. Greater vigilance and more constant attention to changing conditions were necessary than with coal. Otherwise the fireman would blow oil worth many times his wage up the stack. George H. Diman told of the successful use of oil at the mills of the American Woolen Co., at Lawrence, Mass.

In the evening a general war session was held in the ballroom of the Bancroft, among the speakers being Paymaster C. E. Parsons, of the Navy, and Dr. Irving W. Clark, lately returned from the hospitals in France.

The feature of the meeting of the most interest to *Power* readers was a fuel session held in the gymnasium of the institute on Thursday morning and continued in the auditorium of the Administration Building of the Norton Companies in the afternoon. This will be reported in full in future issues.

Though scheduled to last but two hours, the fuel session continued through the day except for the interval when a most excellent lunch was given the society by the Norton Co. The following topical questions were down for discussion, but so interesting were the papers and the oral discussion that items 1 to 7 were all that could be taken up in the time available:

1. What are the Economic Effects of Impurities in Coal?
2. To What Extent is Fuel Oil Likely to be Used as a Substitute for Coal?

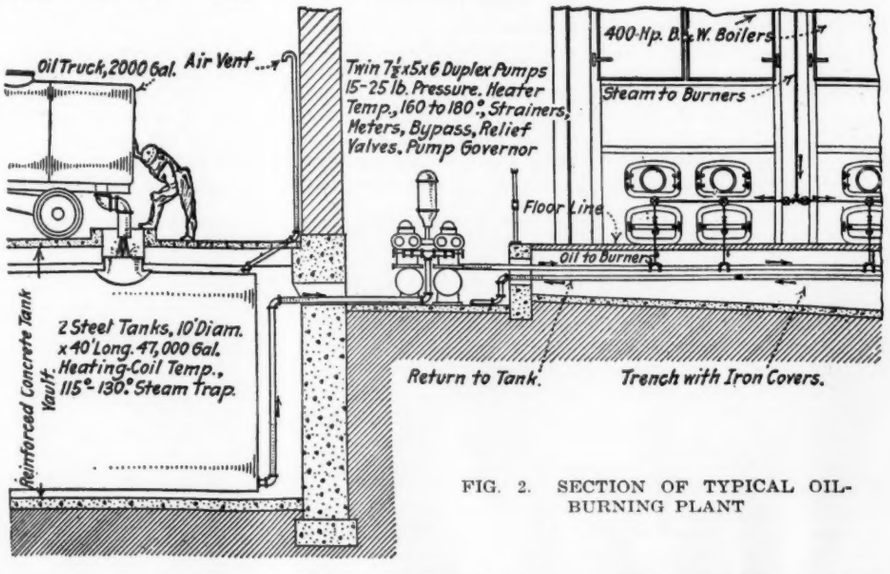


FIG. 2. SECTION OF TYPICAL OIL-BURNING PLANT

3. How Can Soft Coal be Burned Without Smoke in Marine Boilers?
4. What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?
5. What Instruments Are Useful and Desirable in the Boiler Room as Aids, Etc.?
6. What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?

7. To What Kinds of Plants and Coals Are the Different Types of Mechanical Stokers Adapted, and What Is the Limiting Factor to Their Use in Small Plants?
8. What Experience Have you Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?
9. What Coal Economies Can be Effected in Residence Heating?
10. What Coal Economies Can be Effected in the Small Steam Plants?
11. What Experiences Have You Had with the Storage of Coal?
12. A Few Additional Topics: (a) To What Extent and Where Will the Gas Producer be Used to Produce Economies? (b) To What Extent Is Natural Gas Being Used as Fuel for Power Purposes? (c) What Is the Relative Economy of the Locomotive of 1900 and Today? (d) What Proportion of the Coke Is Made in Byproduct Ovens? (e) What Are New and Important Developments in Methods of Burning Coal? (f) What Economies Have Resulted from Recent Practice in Making Brick Settings Leakless? (g) To What Extent Is Coke Being Used for Residence Heating? (h) Is Automatic Air Supply Correctly Proportioned to Coal Supply Possible?

The dynamic address of the session was made by E. L. Cole, secretary of the Pennsylvania Fuel Administration, who spoke, following David Moffat Myers, advisory engineer, Fuel Administration, Washington, D. C.

R. J. S. Pigott offered a resolution, which was adopted, in which the Fuel Administration was urged to do its utmost to reduce the impurities in coal. Prof. L. P. Breckenridge presided at the morning session and F. R. Low at the afternoon session.

It is the intention of the society to publish these fuel papers as a supplement to the *Journal;* this will make a valuable publication indeed.

Friday many of those attending the meeting rode out to Camp Deven despite the rain.

New Jersey N.A.S.E. Convention

The convention of the New Jersey State Association of the National Association of Stationary Engineers was held in Perth Amboy, N. J., June 2 and 3. The attendance was unexpectedly large in view of the modest exhibit of engineering equipment and supplies. The new officers are: President, James S. Heath, Elizabeth, N. J.; vice president, Val. V. Secor, Phillipsburg, N. J.; secretary, A. B. Meincke, Newark, N. J.; conductor, Henry Vail, Plainfield, N. J.; doorkeeper, J. Mack, Perth Amboy, N. J. The convention nominated John J. Reddy, the retiring president, for state deputy, Mr. Reddy having so successfully filled that office two years ago. National Secretary Fred W. Raven agreeably surprised the delegates by attending the convention. The association received with acclaim the report of its educational committee, credit for the year's work of which is due chiefly to C. L. Johnson. This committee was voted the usual appropriation. A publicity committee was created, and this work may be performed by the educational committee. A mimeograph machine will be purchased by the educational committee and by this means every member of each association in the state may be provided with study papers issued by the committee.

A resolution of confidence in the Wilson Administration was ordered sent to President Wilson. Another resolution, directed to Commissioner of Labor Bryant, Trenton, N. J., requested him to try to more thoroughly enforce the engineers' license law.

Pleasant entertainment was provided by Bobby Jones and Billy Murray, of Jenkins Bros., and Jack Armour, of *Power*. Next year's convention will be held at Bayonne, N. J.

New York City Electric Rates

The maximum electric rate in Manhattan and the Bronx, New York City, during 1916 was 8c. per kw.-hr. As a result of the activities of the Mayor and the Public Service Commission of New York City, the New York Edison Co. and the United Electric Light and Power Co. reduced their maximum rate to 7½c. on Jan. 1, 1917, and to 7c. on July 1, of the same year. This agreement was reached with the understanding that the Edison companies would continue this rate after a six-months' trial, provided it was found possible to do so, with the prevailing price of fuel, labor, etc.

On June 3, 1918, representatives of the New York Edison Co. and the United Electric Light and Power Co. appeared before the Public Service Commission and announced that the 7c. maximum rate per kilowatt-hour for electric current would be continued after July 1 of this year, despite the fact that the companies have suffered a decrease in revenue due to war conditions. However, the practice of supplying free lamps to their customers is to be abandoned and a minimum charge of 30c. made for the small-sized lamps and more for the larger sizes.

J. W. Lieb, vice president of the New York Edison Co., stated that the operating revenue of the companies had been reduced $941,654 during the first four months of this year, as compared with the same period of last year, and the reduction of the current sold amounted to 4.5 per cent. for the same period. Mr. Lieb said:

We believe that these conditions would justify the company in going back to the 8c. rate. At the same time it is not absolutely certain that the decrease in output will continue for the rest of the year. We believe that probably the best solution would be a continuance of the present arrangement with the commission, maintaining the status quo for another six months, say, and reserving such rights as we have under the present agreements. This proposal has been accepted by the Public Service Commission.

SOME OF THOSE ATTENDING THE NEW JERSEY N. A. S. E. CONVENTION, PERTH AMBOY, N. J., JUNE 2 AND 3

Western Society Holds Fuel-Supply Meeting

On the evening of June 3 the Western Society of Engineers devoted its attention to the subject of fuel supply. Members of the Coal Conservation Committee of the United States Fuel Administration for Illinois were present to discuss the subject, and they were fortunate to have with them David Moffat Myers, consulting engineer for the Fuel Administration at Washington. Prof. H. H. Stoek, chairman, opened the discussion. From the best information that could be obtained it had been estimated that the additional fuel requirements for this year would be about 15 per cent. An increase of production of 7½ per cent. was the best that could be done, leaving a deficit of 7½ per cent. The plan would be to try and keep all industries going and if need be cut off a little of the fuel supply from each one rather than shut down any of the nonwar plants, as had been proposed at one time. It was of the greatest importance, then, to economize in fuel, and if each coal burner did his part there was a possibility that the deficit would be wiped out.

Mr. Myers Presents the Coal-Saving Plan

David Moffat Myers presented the coal-saving plan that had been prepared recently at Washington, and invited those present to join whole-heartedly in the work. In the past the manufacturer has paid very little attention to the fuel cost and the amount of fuel burned, as it was a very small item in the total cost of production, amounting to 1, 2, 3 or 4 per cent., depending on the product. To make a saving, the manufacturer usually investigated the larger items, including labor, mechanical equipment, raw products, etc., and except where power was the chief product, as in central stations, the power plant received attention last. In order to interest the manufacturer in reducing his fuel consumption, it is necessary to create an incentive, and in the plan now being adopted by many of the states the underlying motive is patriotism. In many cases this will be enough. There are other provisions in the plan to take care of those who neglect to save.

The national plan of organization for fuel conservation in power plants is the result of conference with the United States Fuel Administrators and their committees for a group of states which together consume about 70 per cent. of all the coal used in the country, exclusive of railroads. The plan has been approved also by the United States Bureau of Mines and the committee of consulting engineers on conservation and publicity representing the Engineering Council of the four large national engineering societies. The object is to establish a Government service for the elimination of needless waste of fuel in all power plants, including those in the industries, in office buildings, hotels, apartment houses, etc., and in laying the foundation for the proposed organization, it has been anticipated that this branch of work should become a permanent service of the United States Government.

It has been estimated that 10 to 20 per cent., that is, from 25 to 50 million tons of coal per year, can be saved by the correct operation of steam-power plants, using their present equipment. The effort must be made on this basis, as manufacturing and transportation facilities will not permit of reëquipping the plant. It is considered highly important that all existing fuel conservation committees, committees of chambers of commerce, and national defense, manufacturers' associations and other bodies be continued in full force, and that the work of such organizations be consolidated with the national program. The plan comprises:

1. Personal inspection of every power plant in the country.

2. Classification and rating of every power plant, based on the fairness with which owners of plants conform to the recommendations of the United States Fuel Administration.

3. Responsibility of rating the plant will fall upon the administrative engineers to be appointed by the United States Fuel Administration in each state or district, the rating to be based on information collected by a force of inspectors who will not use their judgment nor express opinions, but merely collect certain definite information included in a questionnaire that has been sent to the plants. After classification and rating of plants according to efficiency of operation, this information will be submitted by the engineer to the state fuel administrator, who shall, in accordance with his judgment, entirely or partly cut off the consumption of coal to any needlessly wasteful plant in his territory. Those plants that follow the recommendations of the Fuel Administration will thus receive the advantage due them for saving coal.

4. Work of the administrative engineers will be to supervise fuel conservation in power plants, including both mechanical and electrical problems connected with the generation and use of steam, power, light and heat, and to supervise the inspection of all power plants in their districts. Inspection will be effected by inspectors of the steam-boiler insurance companies, state factory inspectors, engineering students from technical colleges and volunteers. The rating of each client will be based on the information contained in the questionnaire. Each question will be given a numerical value depending on its relative importance to the other questions, and when the answers are obtained they will be averaged in the same way as an examination paper.

It is further proposed that a standard questionnaire uniform for all states be sent as soon as possible to every power plant in each state or district with notice to the owners that within a certain time, say 60 or 90 days, his plant will be inspected personally and the questionnaire will be checked by the inspector upon his visit to the plant. This action should tend to prepare the minds of plant owners for what will follow and will operate to induce proper care in furnishing the information called for by the questionnaire. It should also create a desire to improve the plants so that they may be rated as high as possible by the time the inspector calls to obtain the information which shall determine the class in which the plant will be rated. The actual rating of plants, however, is to be made by the administrative engineer only after verification and collection of the questionnaires by the inspectors.

Board of Engineers Recommended

In addition to the census of power plants thus obtained it is recommended that a board of competent engineers be attached to the conservation committee in each state in a volunteer advisory capacity to assist the administrative engineer in his work. In addition to numerous other functions, a member of such a board could render valuable service by a personal interview with the owner of the plant that has been given a low rating, pointing out the general causes of inefficiency and aiding the owner in securing the services of a good engineer. Each state should also have available a corps of lecturers who may arouse public interest and disseminate engineering information. To assist in this work the United States Fuel Administration has prepared a fifty-minute film of moving pictures showing good and bad operations in the steam-boiler plant, methods of testing boilers, fuels, etc. The administration is also preparing a series of official bulletins on engineering phases of steam and fuel economics. Also, a list of competent engineers for each state has been prepard in Washington and is available for use by the local administration.

The slogan of the campaign is maximum production with minimum waste. In other words, the object is to operate all industries at full capacity, but at the same time to make a pound of fuel perform its maximum service in power, light and heat.

Dr. F. C. Honnold, fuel distributor of Illinois coal, spoke of the zoning system and how it had affected the distribution of coal from the mines. Illinois had been asked to supply 5,000,000 tons out of the state in substitution for Eastern coal. To do the same work it required from 15 to 25 per cent. more Illinois coal owing to the higher ash and lower heat value. Recently, many Government orders have been placed in the West requiring more fuel for war work, and due to the fact that the Government is

going farther and farther west to get smokeless coal for the transports and naval vessels, there will be shortage of coal for Lake movement so that Illinois will have to step in and supply much of the coal to the Northwest.

Primarily, the speaker had been directed to care for railway work first, war work second, and householders third. In purchasing coal, the householders have shown the proper spirit. They have placed orders for their coal promptly as requested, and as a result the mines are shipping more coal for householders than in any previous month in their history. There has been delay in the railway situation. The question of car supply to the mines has not been settled. There are not cars enough to go around to supply fully all the mines. The average provision in the Illinois territory has been 65 per cent. and in the East the supply is considerably less. The price that the railways are to pay for coal will be settled within a few days.

C. W. Naylor expressed impatience over the delay in formulating the plan for coal conservation. He said they had been waiting since January for this plan and to follow it out as outlined would mean such a tremendous amount of work that all the engineers in the country could not carry it out in time to influence this year's consumption of coal. People were ordering coal now, but could not get it. It was his opinion that if the Fuel Administration would spend less time in zoning and in the preparation of such plans as the one presented, and devote more time to loading, shipping and to the car supply, it would be much more to the purpose. The consumer would take care of the coal when he got it.

Osborn Monnett limited his remarks to low-pressure heating, and A. L. Langtry spoke on coal specifications. He referred to Government supervision of all contracts and the restriction that coal companies shall not contract with their customers for more than 65 per cent. of last year's requirements. The Fuel Administration can take the remaining 35 per cent., if needed, and place it somewhere else. Variations in coal last winter had been partly caused by the coal coming from different districts, and not from the same mine. Data were presented to show that in some cases there was wide variation in ash and in others there was very little difference. The tendency, however, is toward more ash and slate, and this is due to mining conditions which have now been corrected.

Educational Work in Iowa

Royal H. Holbrook, of Cedar Rapids, Iowa, spoke of the educational work that had been conducted in that state last winter. A half dozen of the best operating engineers in the state visited every plant that gave them an invitation. Owing to the shortage, it had been necessary to burn more Iowa coal than usual, and it was necessary to teach users how to burn it. In visiting a plant they always called in the owner so that he could learn first-hand the results of the inspection. Their method was to look first for the absence of pipe covering, then to inspect the system and apparatus for cleaning flues, see that the blowoff was working properly and test the setting for air leaks. At the close of the season they had a fairly good record of all plants visited. The weakness was that they could not enforce their suggestions. Next fall they will be ready to start work again to complete the data required by the new Government plan. It was the speaker's opinion that without an immense number of volunteers the Government plan could not be carried out successfully in Illinois. There are 100,000 plants in Chicago alone, and throughout the state there are many more. It is an enormous task and will require the services of a great many competent engineers.

A. Bement was of the opinion that the greatest difficulty would be experienced in the miscellaneous small plants where CO_2 machines were not in favor. A large number of instruments would be required and many difficulties would arise. In his opinion the better plan would be to employ experienced men who could inspect the fire and the plant, diagnose conditions and prescribe the remedy. Not many men would be competent for such work, and if all the combustion engineers in the country were employed they would still be short of help. In explanation Mr. Myers stated that the incentive would be all that was necessary in eight out of ten cases. The mere fact that the plant was to be inspected and its rating determined from the result of this inspection would induce the owner to put it in the best possible condition.

Robert Kuss expressed the opinion that the engineer would come across in the big patriotic way desired and that as soon as the plan goes out he will be ready to back it up. According to estimate it takes 49½ tons of coal to keep one soldier going for the period of a year and with such tremendous requirements as our growing army will impose, it will be necessary for all to give their undivided support to the movement.

Duty of the Employer in Reconstruction of the Crippled Soldier

By Douglas C. McMurtrie

Director Red Cross Institute for Crippled and Disabled Men, New York City

We must count on the return from the front of thousands of crippled soldiers. We must plan to give them on their return the best possible chance for the future. Dependence cannot be placed on monetary compensation in the form of a pension, for in the past the pension system has proved a distinct failure in so far as constructive ends are involved. The pension has never been enough to support in decency the average disabled soldier, but it has been just large enough to act as an incentive to idleness and semidependence on relatives or friends. The only compensation of real value for physical disability is rehabilitation for self-support. Make a man again capable of earning his own living, and the chief burden of his handicap drops away. Occupation is, further, the only means for making him happy and contented.

Soon after the outbreak of hostilities the European countries began the establishment of vocational training schools for the rehabilitation of disabled soldiers. They had both the humanitarian aim of restoring crippled men to the greatest possible degree and the economic aim of sparing the community the burden of unproductivity on the part of thousands of its best citizens. The movement had its inception with Mayor Edouard Herriot, of the City of Lyons, France, who found it difficult to reconcile the desperate need for labor in the factories and munition works while men who had lost an arm or a leg but were otherwise strong and well were idling their time in the public squares. He therefore induced the municipal council to open an industrial school for war cripples which has proved the example and inspiration for hundreds of similar schools since founded throughout France, Italy, Germany, Great Britain and Canada.

The disability of some crippled soldiers is no bar to returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

The education of the adult is made up largely of his working experience. The groundwork of training in his past occupation must under no circumstances be abandoned. The new trade must be related to the former one or be, perhaps, an extension or specialization of it. For example, a man who had done manual work in the building trades may by instruction in architectural drafting and the interpretation of plans be fitted for a foreman's job, in which the lack of an arm would not prove a serious handicap. A trainman who had lost a leg might wisely be prepared as a telegraph operator, so that he could go back to railroad work, with the practice of which he is already familiar. Whatever training is given must be thorough, for an adult cannot be sent out to employment on the same basis as a boy apprentice. He must be adequately prepared for the work he is to undertake.

The one-armed soldier is equipped with working appliances which have supplanted the old familiar artificial limb. The new appliances are designed with a practical

aim only in view; they vary according to the trade in which the individual is to engage. For example, the appliance for a machinist would be quite different from that with which a wood turner would be provided. Some appliances have attached to the stump a chuck in which various tools or hooks can interchangeably be held. The wearer uses these devices only while at work; for evenings and holidays he is provided with a "dress arm," which is made in imitation of the lost natural member.

An important factor in the success of reëducational work is an early start, so that the disabled man shall have no chance to go out unemployed into the community. In even a short period of exposure to the sentimental sympathy of family and friends, his "will to work" is so broken down that it becomes difficult again to restore him to a stand of independence and ambition. For this reason, therefore, the plan for his future is made at as early a date as his physical condition admits, and training is actually under way before the patient is out of the hospital.

In the readjustment of the crippled soldier to civilian life, his placement in employment is a matter of the greatest moment. In this field the employer has a very definite responsibility. But the employer's duty is not entirely obvious. It is, on the contrary, almost diametrically opposite to what one might superficially infer it to be. The duty is not to "take care of" from patriotic motives, a given number of disabled men, finding for them any odd jobs which are available, and putting the ex-soldiers in them without much regard to whether they can earn the wages paid or not.

Yet this method is all too common. A local committee of employers will deliberate about as follows: "Here are a dozen crippled soldiers for whom we must find jobs. Jones, you have a large factory; you should be able to take care of six of them. Brown, can you not find places for four of them in your warehouse? And Smith, you ought to place at least a couple in your store."

Such a procedure cannot have other than pernicious results. In the first years of war the spirit of patriotism runs high, but experience has shown that men placed on this basis alone find themselves out of a job after the war has been over several years, or in fact, after it has been in progress for a considerable period of time.

A second weakness in this method is that a man who is patronized by giving him a charity job comes to expect as a right such semigratuitous support. Such a situation breaks down rather than builds up character, and makes the man progressively a weaker rather than a stronger member of the community. We must not do our returned men such injury.

The third difficulty is that such a system does not take into account the man's future. Casual placement means employment either as a makeshift job as watchman or elevator operator such as we should certainly not offer our disabled men except as a last resort—or in a job beyond the man, one in which, on the cold-blooded considerations of product and wages, he cannot hold his own. Jobs of the first type have for the worker a future of monotony and discouragement. Jobs of the second type are frequently disastrous, for in them a man, instead of becoming steadily more competent and building up confidence in himself, stands still as regards improvement and loses confidence every day. When he is dropped or goes to some other employment, the job will have had for him no permanent benefit.

Twelve men sent to twelve jobs may all be seriously misplaced, while the same twelve placed with thought and wisdom and differently assigned to the same twelve jobs may be ideally located. If normal workers require expert and careful placement, crippled candidates for employment require it even more.

The positive aspect of the employer's duty is to find for the disabled man a constructive job which he can hold on the basis of competency alone. In such a job he can be self-respecting, be happy, and look forward to a future. This is the definite patriotic duty. It is not so easy of execution as telling a superintendent to take care of four men, but there is infinitely more satisfaction to the employer in the results and infinitely greater advantage to the employee. And it is entirely practical, even in dealing with seriously disabled men.

A cripple is only debarred by his disability from performing certain operations. In the operations which he can perform, the disabled man will be just as efficient as his nonhandicapped colleague or more so. In the multiplicity of modern industrial processes it is entirely possible to find jobs not requiring the operations from which any given type of cripples are debarred. For such jobs as they can fill the cripples should be given preference.

Thousands of cripples are now holding important jobs in the industrial world. But they are men of exceptional character and initiative and have, in general, made their way in spite of employers rather than because of them. Too many employers are ready to give the cripple alms, but not willing to expend the thought necessary to place him in a suitable job. This attitude has helped to make many cripples dependent. With our new responsibilities to the men disabled in fighting for us, the point of view must certainly be changed. What some cripples have done, other cripples can do if only given an even chance.

The industrial cripple should be considered as well as the military cripple, for in these days of national demand for the greatest possible output there should not be left idle any men who can be made into productive workers. With thoughtful placement effort, many men can be employed directly on the basis of their past experience. With the disabled soldiers who profit by the training facilities the Government will provide, the task should be even easier.

This, then, constitutes the charge of patriotic duty upon the employer: To study the jobs under his jurisdiction to determine what ones might be satisfactorily held by cripples; to give the cripples preference for these jobs; to consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor that would otherwise be unproductive; to do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

If the employer will do this, it will be a great factor in making the complete elimination of the dependent cripple a real and inspiring possibility.

Meeting of National Coal Association

At the opening of the first annual meeting of the National Coal Association in Philadelphia, on May 28, the principal address was made by J. D. A. Morrow, Director General of the United States Fuel Administration. The following excerpts are taken from his address:

Every country that has gone into this war has promptly found itself faced with a difficult coal problem. In Great Britain, within six months after war had been declared, 250,000 coal miners had enlisted, and the production in Great Britain fell off 25,000,000 tons. The railways were congested with traffic, and the country faced an industrial crisis.

The important French coal fields were overrun by the enemy at the outset of the war, and production was cut squarely in two. The supply there has been cruelly short, and every pound has been distributed by the government. That has been the case also in Italy.

Thus it is nothing unusual for us to have a coal crisis in this country. You are all familiar with the insatiable demand for coal that coincided with congested traffic on our lines, and within six months after the declaration of war the United States had set up a Federal Fuel Administration, the industry was under Governmental control, and we had followed to that extent at least in the footsteps of other important belligerents.

When I took up the work of directing the distribution of coal, it appeared to me that one of the first things we needed to know was what the requirements for coal would be. To get that information we obtained reports from more than 100,000 industrial concerns, stating the exact quantity they consumed yearly. We obtained reports from 40,000 retail dealers covering their annual deliveries. We obtained reports from the Shipping Board, the War and Navy Departments, and from other Government sources,

regarding the building of new factories and extensions to old ones, and the increase of activity in other plants. We also called upon private sources of information. When we had those figures together, we found that to run the United States on a war basis this year we need 735,000,000 net tons of coal.

It seems likely that the production of anthracite cannot exceed the output of the past year, namely 89,000,000 gross tons. The difference must be made up out of the bituminous mines. The bituminous mines of the United States this year are called on to produce 85,000,000 more tons than they produced last year, which was a record year.

Under these circumstances, then, we clearly and definitely face the prospect of a slight shortage of coal this year. Under these conditions we are trying to see that the domestic consumer is taken care of; that the supreme important users of coal get their supplies, and that if any is left that can go to the less important consumers there is where it will go.

In order to make sure that an equitable distribution is had between these important branches we have to get some very definite information about where the coal is going. We intend to require every industrial consumer of coal in the United States to register and to report weekly his exact amount on hand, his consumption, his receipts and the amount that is moving to him. If we have all this information it will enable us to act intelligently; for we will know, at any time, how any given plant or industry or section of the country stands with respect to its coal supply, and it will then be possible to prevent trouble before it occurs in many instances, rather than to try to cure it afterward.

Distribution Division of Fuel Administration

The Fuel Administration is organizing a conservation division which is to inspect the plants and teach the users of coal better methods of burning it in order that tonnage may be saved. It is estimated that if this can be done on a large scale this year it will be possible to save perhaps 20,000,000 tons of coal. Unless this is done many plants necessarily will be without coal and to some extent will have to curtail operations.

I want to make it clear that the Distribution Division of the Fuel Administration intends to be sufficiently in control of the situation to make sure that the domestic consumer gets his supply, that the railroads have theirs, and that the important war plants are all running, and that our ships get back and forth across the Atlantic. If we do that, if we take care of the domestic consumer and keep these plants running, it will be possible for us to avoid the suffering that occurred last winter and the working machinery of the United States will not lose one single stroke for lack of coal.

The zone system of distribution has proved beneficial to the railroads. The vice president of the Norfolk & Western R.R. gives some idea of how it is helping that road. He says: "A comparison of the movement of loaded coal cars in our coal districts during the seven-day period, May 4 to 10, 1918, to determine the advantages derived from the zone regulations, indicates that there was a saving in loaded car mileage in coal fields of 15.2 per cent. or 6982 loaded car-miles in seven days. This is simply the saving of car miles in the coal regions on our lines and does not take into account the saving that has been effected between the origin zones and the points of destination by the elimination of cross hauls."

This is indicative of the important saving in transportation that was effected by the zoning of coal. That zoning no doubt interfered with customary trade relations, it interfered with the customer in getting his supplies. We have this evidence of the fact that the sacrifices made have greatly helped our transportation problem at a time like this, when that is all-important.

To date we have been most admirably supported by the coal men themselves. There have been times when we have made mistakes, made lots of them; we will probably make a good many more. Nobody knows everything about the coal business nor even a small part about all of it, but we are trying to get together in Washington a personnel of leaders in this business in positions of responsibility, men that the coal industry can follow with confidence and respect.

We now understand that for modern war to be anywhere near successful the armies in the field must be supported by equally effective and magnificent war machines built up in the industrial life of the country behind the armies. Germany had exactly that kind of an industrial machine completed before ever this war began.

It is equally necessary for us to build up here an industrial war machine that will support our military war machine just as effectively as does Germany's. Just as the soldier has to subordinate his wishes to the general plan, so the coal man will find it necessary in many respects to lay aside personal desires and privileges and submit his wishes to the general plan for the industry as a whole in support of the war program.

Engineers Wanted for the Army

Engineers are once more in demand for officers in the army. For the last six months or more all applicants for engineers' commissions have been met with the statement that the quota was full and that except for special work, generally at the direct request of General Pershing, no more commissions would be given in the engineers to men now in civil life. Such vacancies as would exist were to be filled by promotions of men already in the service. Our enormously increased army, both in being and in prospect, has changed all this. Under date of June 3, Gen. W. M. Black, Chief of Engineers, U. S. A., issued a call for approximately 2000 additional first lieutenants and captains in the Engineer Reserve Corps, to be immediately commissioned, sent to training camp and as soon as possible thereafter sent overseas to the Expeditionary Forces.

Qualification restrictions are mainly those of age. There are no commissions available in the grade of major or higher or in that of second lieutenant. The higher grades will be filled by promotions of well-qualified men now nearly a year in the service, the lower grades will be filled from the ranks or from the recent college graduates, members of the Engineer Enlisted Reserve. The age limits are 32 to 36 years for first lieutenant and 36 to 42 years for captain. These limits may be slightly increased, or decreased, in certain cases, except that no one within the draft age will be considered.

No set rules as to professional qualifications and experience have been established, except that the applicant must be engaged in the active practice of the engineering profession, in one of its various branches. An examining board will pass upon the candidate's fitness.

All applicants accepted by this examining board will be commissioned within a week or ten days of the examination and a few days thereafter will receive orders to report at an Engineer Officers' Training Camp, either at Camp Lee, Petersburg, Virginia, or Camp Humphries, Virginia, just down the Potomac from Washington. After a course of training in military engineering, they will be assigned to duty with the engineer troops for eventual service abroad. The commission is not final, however, because a candidate may in camp prove not to have the necessary qualities of a military leader. In such a contingency he will be honorably discharged. Each man's case will be carefully considered just previous to the completion of his course of instruction by a board of officers of the Corps of Engineers, U. S. A.

The Government will allow traveling expenses at the rate of 7c. per mile to applicants who may be commissioned, and they will also receive while in training camp the full pay of an officer of their rank. They must provide themselves with the usual Engineer Officer's uniform outfit while at camp.

Applications for these commissions should be made as soon as possible to the office of the Chief of Engineers, Washington, D. C. The office will send back a series of blanks to be filled out with a general personal description designed to indicate the fitness of the applicant for a more searching examination in person by the examining board. Those selected will be notified when and where to appear before the board for the further examination.

Chicago's Technical Men Unite for War Work

Representing an effort to coöperate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the Military Committee of the Western Society of Engineers, and, at the invitation of that committee, several meetings have been held at the Chicago Engineers' Club. As the result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise, and to coördinate their activities in the most effectual manner to help win the war." It is not intended to attempt any novel "stunts," but rather to place at the disposal of the United States Government, and other authorized agencies, the combined strength and resources of the Chicago technical societies for war work, as need may arise.

The following member societies are coöperating in the new War Committee: Western Society of Engineers; Structural Engineers' Association of Illinois; Society of Industrial Engineers; Illinois Society of Engineers; Illinois Society of Architects; The American Railway Engineering Association; The Swedish Engineers' Society of Chicago; Illinois Chapter, American Institute of Architects; Chicago Section, American Society of Mechanical Engineers; Chicago Section, American Institute of Electrical Engineers; Chicago Section, American Chemical Society; Chicago Section, American Institute of Mining Engineers; Mid-West Section, Society of Automotive Engineers; Illinois Association of American Society of Civil Engineers; Chicago Section, American Society of Heating and Ventilating Engineers; Chicago Section, American Society of Refrigerating Engineers; Chicago Section, Steel Treating Research Society; Chicago Section, Illuminating Engineering Society; and Chicago Chapter, American Association of Engineers.

Officers of the War Committee have been elected as follows: Chairman, F. K. Copeland; vice chairman, W. L. Abbott; secretary, Edgar S. Nethercut; treasurer, William A. Fox. The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins, C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the secretary of the War Committee is 1735 Monadnock Block, Chicago, Ill.

Largest Smokeless Powder Plant in the United States

The largest smokeless powder plant in the United States, known as "Old Hickory," located near Nashville, Tenn., and building by the du Pont Engineering Co., at a contract price of one dollar, has swung into line back of our boys "over there."

The first sulphuric-acid unit has already been started, and the progress which this marks assures the delivery of powder before July 1, three months ahead of the original schedule, in quantities sufficient to keep a steady flow going to the battlefront in France.

This marks the first completed step of a monumental task which sets a record for engineering and construction work in the United States. The original contract with the United States Government for the building of this plant was signed with the du Pont Engineering Co. on Jan. 29 of this year. It called for a daily output of 500,000 lb. of smokeless powder with the first unit to operate in eight months, or Oct. 1, succeeding units, four in number, to come into commission every six weeks.

On Mar. 23 a new contract was entered into which turned the plant over to the du Pont Engineering Co. as contractors for the Government. Under its terms the contractors were to construct a plant based on their knowledge and experience complete in every detail to turn out 900,000 lb. of powder a day. Under this new arrangement the contractor agreed to bring the first unit into operation on Aug. 1, two months ahead of the previous schedule, and to bring the other units in thirty days apart.

Under this final plan the contractors agreed to do the construction work for a consideration of one dollar. This work included giving to the Government the benefit of all the du Pont skill and knowledge in the design and construction of powder plants gained through long years of actual operating and exhaustive experimental work, and rendered all the more valuable because of the experience gained in the building of modern war plants to supply the powder demands of the Allies before this country entered the war.

With the freedom of action obtained under the final contract, such rapid progress was made that two months ago, when the powder situation became acute, the contractors promised the Government to again put forward the schedule and to produce powder on July 1, bringing into operation the successive units twenty-five days apart. To meet this schedule it would have not been necessary for the sulphuric-acid plant, which started June 1, to have been put in operation for another ten days, so that there is every prospect that some additional time may be saved even on the close schedule finally adopted.

Each one of these units is practically complete within itself and is approximately eight times the size of the largest smokeless-powder plant in the United States prior to the war. The entire plant is approximately seventy times the size of the largest smokeless powder plant in the United States prior to 1914.

There will be a complete power plant for generating electric power and steam. This plant will have eight stacks, 15 ft. in diameter and 200 ft. high.

The plant will consume 4500 tons of coal every operating day of twenty-four hours. This is equivalent to 100 carloads or two trainloads. The completed plant will require 100,000,000 gal. of water every twenty-four hours, or as much water as is used by a city of 1,000,000 population; 65 per cent. of this water must be treated and filtered. The central power plant will contain 68 boilers, each with a rating of 825 hp. These will be operated at an overload, developing approximately 90,000 boiler horsepower, supplying steam for generating 12,000 kw. of electrical power as well as steam power for the treatment of guncotton and other purposes.

In addition to the railroad which is built into the plant, it was necessary to reconstruct the highways leading from Nashville, and within the plant itself many miles of standard railroad track and narrow-gage lines are in operation. The finished plant will contain approximately 33 miles of broad-gage track and 46 miles of three-foot gage track for narrow-gage locomotives and cars.

Wisconsin Modifies Second-Hand Boiler Ruling

It has come to the attention of the Industrial Commission that several manufacturers of this state have found it difficult to obtain new boilers to assist in increasing the production of the factories, and this condition is the result of the scarcity of steel plate which is largely being used in the manufacture of war materials. Consequently, buyers are obliged to make use of second-hand boilers.

With this in mind, the commission at its last regular meeting, May 20, 1918, voted to modify until further notice Order 4208, page 12, Code of Boiler Rules, to the extent that it will be satisfactory to admit for operation with a factor of safety of (5) any second-hand boiler whose longitudinal seam is of the butt type and with double covering plates, with the understanding that the boiler does not conform strictly to all the requirements of Part III of the rules which apply to boilers installed after July 1, 1916.

For example, a second-hand boiler as described may be a trifle short in bracing; have only single lugs for support; blowoff pipe 4 in. in diameter; manholes smaller than required on new boilers; or it may have a dome which would not conform to Order 4348.

Illinois State Convention N.A.S.E.

On June 5-7 the Illinois State Association of the National Association of Stationary Engineers held its fourteenth annual convention at Ottawa. Owing to the busy times, when the engineer in particular must be on hand to keep the wheels going, the number of delegates and visitors attending was less than usual, and although about the same number of booths had been taken, the exhibits were few and none of them elaborate, due to overcrowded transportation facilities and the rush of war work. Headquarters and the exhibit hall were at the Clifton Hotel and the business sessions of the convention were held in the K. of P. Hall.

At 2 p. m. Wednesday W. F. Kirschenberg called to order the first session of the convention. Rev. C. A. Briggs, Jr., opened with prayer. Mayor E. F. Bradford extended an earnest and cordial welcome and presented a large gilt key giving access to anything in the city. He said that he had been impressed by the aims and objects for which the association had been formed, that the idea was splendid and should bear fruit in these times when efficiency in the power plant meant so much. He expressed the hope that their stay would be so pleasant and profitable that Ottawa would be their favorite convention city.

DELEGATES AND THEIR GUESTS ATTENDING THE FOURTEENTH ANNUAL CONVENTION OF THE ILLINOIS

In his response John F. McGrath expressed the appreciation of the delegates for the kind reception. He dwelt briefly on the educational features of the association and on the wonderful success of the lantern-slide lectures. The organization tried to keep the men abreast of the times, not only mechanically but socially as well, so that they might feel that they were on an equality with men in any walk of life.

Joe O'Connell was always pleasantly impressed by the fact that public men such as the mayor or the governor never failed to recognize the value of the engineer to the community. They were students of human nature and understood the engineer better than most other men. With water-works, lighting and power plants of all kinds, street railways, locomotives and marine plants under their control, the engineer had it in his power to create terrible hardships, if he so willed and organized for that purpose. To the credit of the profession the present organization had been formed for fraternal and educational purposes.

J. F. Farrell, ex-mayor, referred to the previous convention in Ottawa and expressed the wish that it might become a permanent issue to meet in the city every year. Upon request the speaker read a paper on "Economy of Coal and Fuel Conservation," by C. W. Naylor, who had been unable to attend. It was Mr. Naylor's contention that in one way the present war was a blessing. It had opened the eyes of the people to the fuel situation and the need for economy in this natural resource. During the coming year it would be impossible to increase much if any, the output of coal. Consequently the user must secure greater economy, the mines must be kept busy the year around and the coal be equally distributed in accordance with the needs. Each individual must wake up to the situation. The householder will be forced to burn mostly Illinois coal and it was up to him to order it now instead of waiting with the hopes of getting anthracite or Pocahontas. Reference was made to ways of saving, such as the elimination of needless lights, shorter working days for those engaged in nonwar work and rigid economy in the power plant. It was possible to get help from the fuel administration. Lecturers were to be sent all over the state and there would be men and literature to show how to burn Illinois coal. To help win the war Mr. Naylor urged general storage of fuel during the summer months and made a special plea to the engineer to spread the gospel of fuel conservation.

Lee O'Neil Browne, an honorary member of the association and the representative of the state legislature who had twice helped the engineers in trying to put through a license bill for Illinois, spoke briefly. He referred to the previous convention at Ottawa eight years ago when he had become a member, and to the great help certain engineers had given him in a boiler explosion case in Lee County. He reviewed the efforts made to pass the license bill against the opposition of certain labor organizations in Chicago and sawmill and other small interests in the southern part of the state. In the second attempt the bill had been passed in both the House and the Senate, but had been vetoed by the governor for the averred reason that it contained too many restrictions. In his opinion the bill could be passed again, but before it reached the governor there would be need of concerted effort to arouse public interest and to create a demand backed by powerful influences that could not be overlooked.

With the official opening of the convention and appointment of committees by John F. Alt, state president, the session closed.

In the evening the exhibit hall in the Clifton Hotel was opened officially, with J. F. Alt presiding. Short talks were made by Messrs. Thayer, Fiske, Lane, McGrath and Roberts on the educational advantages offered by the exhibits. The latest equipment, or literature dealing with it, was on display and valuable information could be obtained from the various salesmen.

Thursday morning the session was given over to routine business and reports. The secretary-treasurer's statement disclosed a comfortable working balance and a net loss in membership of 23 for the state. Mr. Roberts, of Cleveland, a member of the National License Committee, discussed the

possibilities of eventually passing the Illinois bill. He thought the conditions favorable. Recent experience showed what must be overcome and they were fortunate in having a representative who had their interests at heart. The speaker warned against trying to get all that was wanted in the bill. It would be policy to get the best bill possible on the statute books and after that amendments would be comparatively easy. To be constitutional the bill must have uniform application throughout the state and there should be no restrictions as to qualifications of the chief examiner. It would be better to let the appointive power assume the responsibility. Sources of objection could be eliminated by giving without further examination, state licenses to men who already possess a city license and to engineers who have been operating for a certain period and can verify it by a statement from their employers. One of the causes of the veto of the last bill was the exemption clause expressing the limit below which a license would not be necessary, in square feet of heating surface rather than

STATE ASSOCIATION OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS AT OTTAWA, ILL.

in horsepower. To the layman the former meant nothing while all were familiar with the horsepower.

Mr. Roberts had a pamphlet giving proper information to bring before the public and a skeleton bill after the Massachusetts and Ohio plans which might serve as the fundamental basis for the Illinois bill. Incidentally, the national license committee in conjunction with the national president, had decided to limit their efforts to those states where the possibilities of license legislation were most favorable. For 1918-19 Illinois and Kansas had been selected.

Thursday afternoon the entire delegation had a most pleasant outing at Starved Rock State Park, getting back in time to attend the smoker that evening at the headquarters hotel. The latter was a most enjoyable affair and the best attended session of the convention. With Fiske as toastmaster the program was conducted with despatch. Patriotic talks by President Griggs, of the Chamber of Commerce, and ex-Mayor Farrell were interspersed with songs by the audience. John Lane responded and in brief talks was followed by T. W. Roberts, W. E. Hill and Charlie Fiske. Mob singing led by Tilley and dancing were the final features.

At the Friday morning session, State Deputy Hill spoke of the difficulty all organizations have in holding their membership during war times. The draft and enticing positions opened up by the Federal Government were responsible and it required a great deal of intensive work for an association to hold its own.

In the discussion on educational work, Messrs. Hill, Misostow and Harris emphasized the difficulty the state body had in learning what the smaller associations needed. Lectures suitable for locals in large cities often were not appropriate for towns where the membership did not exceed 20 or 30. Questions and answers and traveling lecturers had been tried and in numerous cases did not seem to meet the requirements.

In choosing the officers, John F. Alt and J. E. Noden were reëlected as president and vice president, respectively. On account of war work Gus Anderson was replaced by W. E. Hill as secretary-treasurer and M. E. Harris was recommended for state deputy. The officers were installed by Past Presidents Parker and Misostow. The selection of a convention city was left for later determination by the president and secretary.

The following firms had space in the exhibit hall: Anchor Packing Co., V. D. Anderson Co., W. A. Blonck & Co., Crandall Packing Co., Dearborn Chemical Co., Garlock Packing Co., Hawk-eye Compound Co., Hays Instrument Co., Jenkins Bros., H. W. Johns-Manville Co., Lunkenheimer Co., National Atomizer Co., *National Engineer*, Perolin Co. of America, Wm. Powell Co., *Power*, S. C. Regulator Mfg. Co., Rhodes Metallic Packing Co., John A. Roebling Sons Co., United States Rubber Co., Thayer & Lynn, Tilley-Gillette Co.

Bituminous Coal Consumption

Following is a statement by the Fuel Administration on coal consumption and requirements. Note the large increase in coal required by industrial plants.

ESTIMATED CONSUMPTION OF BITUMINOUS COAL IN THE UNITED STATES IN 1917 AND REQUIREMENTS FOR 1918–19, IN NET TONS

	1917 Tons	1918–19 Tons	Per Cent. Increase 1918–19 Over 1917
Industrial	204,907,000	242,024,000	18
Domestic	66,915,000	75,678,000	13
Gas and electric utilities	33,038,000	37,941,000	15
Railroads	155,000,000	166,000,000	7
Exports	24,000,000	24,000,000	0
Beehive coke	52,450,000	52,450,000	0
Bunker—Foreign	7,700,000	10,000,000	30
Bunker — Domestic including Great Lakes	5,000,000	5,000,000	0
Used at coal mines for steam and heat	11,000,000	12,500,000	14
Total	560,010,000	625,593,000	12
Used from storage	4,375,000	.....	
Exports	907,000	.....	
Estimated production	554,728,000	.....	
Substitution of coal for oil, mainly in west	.....	2,000,000	
To increase stocks of industrial plants and public utilities outside of New England by ten days' supply	.....	7,000,000	
Total requirements for 1918 without allowance for estimated conservation	.....	634,594,000	
Production, 1917	554,728,000	.....	
Production, 1918, required for needs	634,594,000	.....	
Increase required	79,866,000		
Percentage	14.4		

Thirty-second Convention A.O.S.E.

The American Order of Steam Engineers held its thirty-second annual convention at Philadelphia, June 10-12, with headquarters at the Hotel Vendig. The several sessions were held at the Parkway Building, on Broad Street. The attendance was not as large as usual, owing to war conditions; there were fifty delegates present. The business of the convention was conducted with harmony and dispatch. The treasurer's report showed that the organization is in a sound financial condition. The Supplymen's Association held its exhibit in a large hall adjoining the meeting room of the delegates. There were 46 firms represented. This year a small table display took the place of the customary elaborate exhibit. The entertainment features were a smoker in the Parkway Building on Monday evening and an entertainment and dance at Moose Hall on Tuesday night. The following supreme officers were elected: J. William Pairent, chief; Eugene Enderle, first assistant chief; Harry Dunn, recording engineer; William S. Wetzler, corresponding engineer; William H. Tyson, treasurer; James G. Steigerwalt, senior master mechanic; C. F. Eisele, junior master mechanic; Harvey Berger, inside sentinel; John Orean, outside sentinel; James Lightfoot, chaplain; James K. Holland, trustee. The executive committee consists of George W. Richardson, Clifford P. Williams, and Franklin R. Moore.

At the meeting of the Supplymen on Tuesday the following officers were elected: Horace A. Smith, president; Porter G. Jones, vice president; Roy C. Downs, secretary; John W. Armour, treasurer; William Lindenfelser, Jr., director of exhibits. The date and place of the next meeting will be decided later by the supreme chief.

Coal Trade of Southern Chile

Consul John R. Bradley says, in *Commerce Reports*, that at this time there are no stocks of imported coal in Magallanes. For domestic consumption a lignite to the amount of about 3500 tons per month is produced locally, an analysis of which (perhaps a picked sample) is: Moisture, 18.752 per cent.; volatile matter, 37.892 per cent.; fixed carbon, 31.5 per cent.; and ash, 11.785 per cent. I am told, however, that the ash content is nearer 25 than 11 per cent. This coal retails now at the equivalent of $10 per ton, United States currency.

Prior to the war (and occasionally since its outbreak) practically all steam coal used here came from Cardiff and sold around $12 per ton. Most of that used here is now secured at Coronel, Chile, and is said to be a fair grade of bituminous. The yearly consumption of steam coal at Punta Arenas is estimated to be 15,000 tons, used by about twenty small steamers in the coasting trade, with this as their home port, and one freezing works, which uses about 2000 tons per annum. The other freezing works in this district burn wood, as does the electric-light plant, which pays about $10 per cord. Many of these plants would use coal if available at a reasonable price.

There are no facilities at Punta Arenas for handling coal, and it is unloaded by means of canvas slings and steam winches. Five or six hundred tons a day is about the usual progress made in unloading.

Coal Production Highest This Year

Bituminous-coal production for the week ended May 18 was estimated at 11,732,000 net tons, compared with 11,825,000 for the week ended May 11. The daily average for the week was 1,955,000 tons, compared with 1,971,000 tons for the week preceding, according to the reports issued by the United States Geological Survey.

Anthracite shipments were reported as 41,011 cars during the week of May 18, an increase over the previous week of 2244 cars, or 6 per cent.

The reports made by the United States Fuel Administration showing the working condition at the mines during the week of May 11 are especially interesting in that they reflect the operations of the mines for the weekly period showing the highest production since the organization of the Fuel Administration. The total losses from all causes during the week is recorded at 22.4 per cent. The losses were reported as follows: Car shortage, 11.2; labor shortage and strikes, 5.4; mine disability, 3.6; no market, 1; all other causes, 2.2. The percentage of production to total capacity for week ending May 11 was 76.6 per cent., the highest point attained this year.

Good Suggestion for Home Use Also

Every man that we send to France, whether for the firing line or behind it, will have to be supplied with electric service. The shops for repairing our rifles and guns in France will probably be larger than our munitions plants in this country, according to the *Electrical World*. As France has no coal to spare, we must either make use of some of our ships for transporting our own fuel to produce this power or obtain the power from other sources. The American way is pointed out. Hydro-electric power will not only provide for our own needs in France better than it can be done by sending over American coal, but the very large power needs of France herself can be met by American electrical plants.

Present development of hydro-electricity in France consists chiefly of small generating stations on streams, distributing current to a few near-by towns and villages. With American practice, it would be possible to develop all the available water power on a range of mountains and distribute it through several provinces. The sum of money required to build two 5000-ton steel colliers would build a 10,000 hp. hydro-electric plant in France, according to the estimates. Two such ships could easily take over all material required for construction. A plant of that character would require fewer than half a dozen men for operation. American electrical apparatus is now so practical and diversified that some of it can be set up outdoors with little shelter, and units of 1000 to 10,000 hp. can be located according to water power available and energy needs by American emergency construction which would have them in place and deliver power in from six to nine months.

Fuel Administration Warns Against Unnecessary Lighting

United States Fuel Administrator Garfield has warned the public against prodigal and unnecessary use of electricity for outdoor advertising purposes and other display illumination. Statistics obtained by engineers of the Fuel Administration reduced to terms of coal show the necessity for the utmost fuel economy during the summer as well as the winter, requiring the strictest conservation of fuel-generated electricity. The Administration expects that there will be no extravagant or unnecessary use of electricity for display purposes. If there is, the so-called lightless night order will be suspended and even more stringent restrictions will be ordered against all forms of outdoor lighting and display illumination. The consumption figures just compiled reveal the necessity for the utmost economy in fuel consumption during the summer as well as the winter and require the earliest enforcement of the strictest economy in all fuel-generated electricity.

Ancient Aeronautics

When floods washed away two bridges over the Nisqually River, the Standard Oil Co. of California had to revert to primitive methods to get oil supplies to the eastern half of Lewis County. A large cable was strung across the river, and for three weeks this aërial ferry was the only line of communication. An automobile was used to furnish power at one end, while strong men operated the device from the other. Oil was sent over in 5-gal. cans, and from these filled into barrels. Factories and motorists of Lewis County were thereby permitted to continue using gasoline and other oil products uninterruptedly. — *The Wall Street Journal Straws.*

New Publications

THE STORAGE OF BITUMINOUS COAL. By H. H. Stoek. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill. Paper, 6 x 9 in.; 192 pages. Price, 40c.

This book, which is a bulletin of the University of Illinois and designated as Circular No. 6, is perhaps the most comprehensive publication yet written on the subject of the storage of coal. There are 63 illustrations and 7 tables. It is the purpose of this circular to present a review of modern practice covering the storage of coal and a statement of the facts that have developed in the experience of those who have successfully or otherwise undertaken to store coal. The discussion is confined largely to bituminous coal, which has given so much trouble, owing to its tendency toward spontaneous combustion while stored, and to storage systems and mechanical devices.

MODERN LOCOMOTIVE VALVES AND VALVE GEARS. By Charles L. McShane. Published by Griffin & Winters, Chicago. Cloth, 317 pages; 5 x 7½ in.; 113 illustrations. Price, $2.50.

In writing this book the author has assumed that the reader has no previous knowledge of valves or valve gears, and so he begins with fundamentals. He describes the working of the plain slide valve with neither lap nor lead and then proceeds to show the effects produced by giving lap and lead to the valve and angular advance to the eccentric. From a study of the plain slide valve he passes naturally to special forms of slide valves, balanced valves and piston valves. A striking feature of the book is the omission of the valve diagrams so commonly used in books on valve gears for the solution of valve-motion problems. Instead, a simplified displacement diagram is employed to show the relative positions of valve and piston at admission, cutoff, etc. Apparently this diagram does not take into account the effect of connecting-rod angularity. The Walschaert, Baker-Pilliod, Southern and Young types of valve gear are taken up in detail and instructions are given for setting each and for making the necessary repairs in case of breakdown on the road. The language of the author is simple and direct, and the text is supplemented and explained by a large number of excellent illustrations. A commendable feature is that the various diagrams are pertinent to the discussion and no illustrations are used merely for the purpose of adding to the length and appearance of the book. A full list of definitions of terms forms part of the work, which is thoroughly practical throughout and should be of value to apprentice, fireman, engineer and mechanic.

ELEMENTS OF MACHINE DESIGN. By Henry L. Machman. Published by John Wiley & Sons, Inc. New York. Cloth, 245 pages; 5½ x 9 in.; illustrated. Price, $2 net.

The contents of this volume are arranged under three headings, the first relating to the strength of material, the second to fastenings, which include screw fastenings, riveted joints, keys and cotters, and shrink-and-force fits. The third section is devoted to transmission machine parts. This includes the chapters on shafts and axles, couplings and clutches, journals and bearings, belts and pulleys, friction wheels, tooth gears, rope transmission, chain gearing, pipes and cylinders, valves, flywheels, crankshafts, crankpins, and eccentrics, connecting-rods, piston rods and eccentric rods, pistons, crossheads and stuffing-boxes, hoisting-machinery data and springs. There are 22 chapters in all, the last one being devoted to the materials of machinery.

This book is intended primarily as a classroom textbook and is of more use to the student on the whole than it is to the operating engineer, although the latter will find much of value if he is interested in figuring out or designing machine parts. The author has developed the equations for the design of the more common machine elements, which have been done concisely, and frequently only an outline of the deduction has been given. Empirical formulas and rule-of-thumb methods have been avoided as far as possible.

Illustrations have been chosen to show typical construction rather than a great variety. Each subject treated is designated by black-face type, which makes it convenient to the reader when looking for any particular subject.

MECHANICAL LABORATORY METHODS OF TESTING MACHINES AND INSTRUMENTS. Second Edition. By Julian C. Smallwood. Published by D. Van Nostrand Co., New York. Leather, 399 pages; 5 x 7¼ in.; 114 illustrations. Price, $3.

This second edition has been revised and enlarged to a considerable extent. As the title of the book implies, it is devoted to methods employed in testing various apparatus found in power plants as well as for laboratory uses. In dealing with the various classes of instruments this volume briefly explains the principle of design and operation. The illustrations used to assist in such explanations are diagrammatic so as to make a simple presentation. Such instructions as to how to operate engines, boilers, etc., have been omitted, as the reader is supposed to know about such matters.

In enlarging this volume, the section dealing with instruments contains a number of subjects not covered in the previous edition, and this especially applies to recorders. Furthermore, the section treating on valve setting and steam-engine testing has been enlarged and improved. Engineers will be interested in the section devoted to the testing of condensers and feed-water heaters and other auxiliaries; also in the new section that has been added on the testing of refrigerating machinery, ammonia, absorption and compression systems. Another added feature relates to the testing for the horsepower output of electric motors which should be convenient in connection with the testing of motor-driven units. In all there are twelve additional tests.

Owing to the manner in which the text matter has been got together, the volume is not above the head of the average engineer, and although there are numerous formulas, none are of such character as to prevent one with a common knowledge of mathematics from working them out. In fact, numerous problems have been worked out to assist in their comprehension.

MANUFACTURING OPPORTUNITIES IN THE STATE OF WASHINGTON

Issued by the Department of State through its Bureau of Statistics and Immigration, setting forth the manufacturing opportunities in that state. The book has 240 pages, 5½ x 8½ in., 75 illustrations and several maps. It is the result, as set forth in the preface, of a more or less complete survey of conditions favoring the establishment of additional manufacturing plants in the state, but the broadness and diversity of the subjects discussed preclude the presentation of details. Additional information and any possible assistance will be gladly furnished by the State Bureau of Statistics and Immigration, the Industrial Bureau of the State University, and the Departments of Science and Engineering of the State University and State College.

Personals

F. F. Espenschied, who has been assistant engineer with the Hydro-Electric Power Commission of Ontario, Canada, and prior to that was general manager of the Interstate Light and Power Co., Galena, Ill., has joined the forces of the Combustion Engineering Corporation, 11 Broadway, New York City.

Engineering Affairs

The Society of Automotive Engineers will hold a meeting at Dayton, Ohio, June 17-18. The papers will treat on refining of petroleum, aëronautic engineering, tractor engineering and the design of heavy fuel engines.

Miscellaneous News

A Boiler Exploded in an automobile and bicycle rim factory at Onaway, Mich., on May 30, killing one person.

A Boiler Exploded on a mine engine used at Jackson mine, Lonaconing, Md., on June 1, injuring an engineer and a miner who were riding to the mine.

A Boiler Explosion in the plant of the Monogram Laundry Co., at Muskegon, Mich., on May 30, practically wrecked the building. Although the explosion occurred during working hours, nobody was injured.

A Flywheel Exploded in the electric light and water plant of Clay Center, Kan., on May 26, killing the chief engineer and completely wrecking the electrical and water-works plants, causing a damage estimated at nearly $40,000. Parts of the flywheel were found one block from the plant. The engine was a Skinner Unaflow, and a defective governor is thought to have caused the trouble.

Two Boilers Exploded at the Hammer Lumber Co.'s mill, 25 miles east of Conway, S. C., on May 27, killing five men and injuring five others. The explosion is the worst recorded in the county, and the cause is given as being high steam pressure. The boilers were hurled 300 yards, one piece being thrown nearly a mile. Beside the loss of life considerable damage was wrought upon the plant.

A Boiler Explosion in the plant of the Bartlett Lumber Co., at Shelldrake, in an isolated part of Chippewa County, Michigan, on June 3, is reported as having caused the deaths of ten men and injuries to a number of others. As there is no direct wire communication with the settlement and to reach it involves a boat trip of nearly 50 miles, the authorities, at this writing, were having difficulty in obtaining definite information concerning the cause of the explosion.

The Chicago Wireless Institute, the object of which is to prepare men to pass the United States Government examination necessary to obtain a first-grade radio operator's license, is at 220 South State St., 800 Consumers Building. Day classes are held five days a week from 1 to 5 o'clock, and evening classes from 7 to 10 o'clock. The instructing engineer is R. R. Haugh, of Detroit, who is a member of the American Institute of Radio Engineers. The tuition fee is $50 for the entire course.

The College of the City of New York is giving a special course in shipbuilding and navigation under the direction of John Martin, formerly nautical expert, Hydrographic Office, U. S. N., which began Tuesday, June 18 and will close Sept. 14. In this intensive course the instructor will attempt to prepare students who have had the necessary fundamentals of the service, mathematics and elementary mechanical drawing, for positions of tracers and draftsmen in Government shipyards. These workers are much needed, and the pay varies from $25 to $40 per week. Those desiring to take this course should communicate with the college, Room 16, Main Building, 139th St. and Convent Ave., New York City.

Trade Catalogs

"Centrifugal Boiler-Feed Pumps." The De Laval Steam Turbine Co., Trenton, N. J. Bulletin N; 8½ x 11 in. Describes the De Laval combined steam turbine and centrifugal boiler-feed pump, and also electric motor-driven units.

The Wheeler Condenser and Engineering Co., Cartaret, N. J., has, under agreement with the Sugar Apparatus Manufacturing Co., acquired the exclusive right to manufacture and sell evaporating apparatus under the patents of S. Morris Lillie, president of that company.

The Lillie Evaporator. The first booklet relating to the Lillie Evaporator, published by the Wheeler Condenser and Engineering Co., Carteret, N. J., is just off the press. The device is now manufactured exclusively by this company under agreement with the Sugar Apparatus Manufacturing Co., owners of the Lillie patents. This new booklet calls attention to the factors which make the evaporator especially suited to the concentration of waste waters or liquors in numerous industries. Five pages are devoted to tables that are of especial value in the evaporation industry. A folding page insert gives instructions for operating Lillie quadruple effects.

Scientific Industrial Illumination is the title of a 36-page illustrated booklet recently issued by the Holophane Glass Co., 340 Madison Ave., New York City. It is divided into four parts. The first part shows the need for scientific illumination and discusses its economic advantage. The second discusses the fundamental principle of scientific illumination. The third describes and illustrates new types of industrial lighting units manufactured by the company for shop, factory, office and drafting room illumination and for yard and protective lighting. The fourth contains a collection of general engineering data which should make this booklet valuable for ready reference.

NEW CONSTRUCTION

Proposed Work

Mass., Lawrence—The United States Worsted Co. plans to build a steel boiler house. Estimated cost, $25,000.

Conn., New Britain—The State Board of Education, Capitol, Hartford, will receive bids until June 18, for the installation of a modulation and heating system in the State Normal School on Prospect St. Davis & Brooks, Lewis & Gold Sts., Hartford, Arch.

N. Y., Amsterdam—J. Kayser and Co., 34 Elk St., plans to build an addition to its power plant in connection with its proposed 4 story, 100 x 200 ft. silk mill. W. Higginson, 13 Park Row, New York City, Arch.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, received an only bid for installation of a heating system in the Central Islip State Hospital, here, from the W. B. Armstrong Co., 3 Fulton St., Albany, $36,588 and for the lighting system, from the Babcock and Wilcox Co., 85 Liberty St., New York City, $66,933.

N. Y., Newark—A. W. Beaven, Pres. of the Board of Managers, New York State Custodial Asylum for Feeble Minded Women, Newark, will receive bids until June 28, for the installation of a heating plant and equipment for same. Noted Apr. 30.

N. Y., Brooklyn—The Lasky Motor Car Co., 17 Grahm Ave., is in the market for electric motors, etc., to be installed in its garage.

N. Y., Long Island City—L. Gold, 44 Court St., Brooklyn, will install a steam heating plant in its proposed 2 story, 95 x 100 ft. garage to be erected on Webster and 5th Ave. Total cost, $75,000.

N. Y., Long Island City—The Racich Asbestos Co., 609 West 55th St., New York City, plans to install a steam heating and steam piping system, boilers, 3 electric motors, etc., in its proposed 3 story factory on Hancock St. and Harris Ave. Total cost, $60,000. E. Richardson, 100 Amity St., Arch.

N. Y., Warwick—The Board of Inebriety, 300 Mulberry St., New York City, plans to build an Institution group. Various units include dormitories, power house, etc. Total cost, $200,000. S. Levy, Pres. C. B. Meyers, 1 Union Sq., New York City, Arch.

N. J., Jersey City—R. W. Sailer, Arch., 76 Montgomery St., is receiving bids for the installation of electric lighting, heating and power systems in the proposed 4 story factory on Montgomery St., for the National Grocery Co., Montgomery St.

Md., Baltimore—The Mallory Machinery Co., 522-524 Light St., is in the market for a 150 K. W. or 200 kw. d.c. direct-connected generating set; 250 volt with field rheostat.

W. Va., Kingwood—The Hoffman Coal Mining Co., recently incorporated with $30,000 capital stock, plans to build an electric power plant in connection with its mine. O. Hoffman, Pres.

N. C., Hiawasse—The Carolina Tennessee Power Co., c/o Bertrom Griscom & Co., 421 Chesnut St., Philadelphia, Penn., has received court's permission to erect a hydro-electric plant on Hiawasee River. The project involves developing 60,000 hp. for transmission by electricity.

La., Rayne—City issued $35,000 bonds to improve the electric-light plant and water-works.

Ohio, Lorain—The W. S. Automatic Co. plans to build a 40 x 120 ft. power plant in connection with its proposed new factory. Total cost, $100,000.

Ill., Chicago—The Board of Local Improvement is in the market for electrical power equipment in connection with its proposed Michigan Ave. improvement project. Total cost, $2,000,000. C. O. Hill, Engr.

Ill., Chicago—The Bunting Boiler Co., Lowell Ave., is having plans prepared for the erection of a 1 story, 75 x 200 ft. boiler plant on 16th St. Estimated cost, $30,000.

Ill., Woodstock—The Woodstock Typewriter Co., North Dearborn St., Chicago, plans to build a 1 story, power house here. Estimated cost, $10,000.

Wis., Milwaukee—A. C. Downing, 787 Shepard Ave., is in the market for boilers, engines, generators, motors, etc., in connection with its proposed 225 x 250 ft. plant. Total cost, $150,000. O. C. Uehling, 511 First National Bank Bldg., Engr.

Colo., Loveland—City issued $79,000 bonds for the erection of an electric lighting plant.

Wash., Vancouver—The Columbia River Interstate Bridge Commission, Clarke Co., will receive bids until June 28, for the erection of a transformer house on Washington St.

Man., Gladstone—City plans to build an electric lighting plant soon. About $15,000 is available for the project.

CONTRACTS AWARDED

Mass., Boston—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for improvements to its power plant at the Navy Yard, here, to Rideout Chandler and Joyce, 178 High St. Estimated cost, $31,000. Noted June 11.

Mass., Boston—The United States Government has awarded the contract for the installation of electricity in the Boston Quartermasters Terminals, South Boston, to E C. Lewis ,Inc., 21 Federal St. Estimated cost between $1,000,000 and $1,500,000.

N. Y., Buffalo—The Buffalo General Electric Co., 206 Electric Bldg., has awarded the contract for the erection of a 1 story, 100 x 110 ft. power sub station, on State St., to Huntley & Derdinger, Electric Bldg. Estimated cost, $25,000. Noted June 11.

N. Y., Buffalo—Cousins & Co., 74 Wabash St., has awarded the contract for the erection of a 1 story, 95 x 125 ft. boiler shop, to B. I. Crocker, 57 Builders Exchange. Estimated cost, $35,000. Noted May 28.

N. Y., Mineola—The Curtiss Aeroplane Co., 1927 Elmwood St., Buffalo, has awarded the contract for the erection of a 1 story, 100 x 260 ft. factory, to the J. W. Cowper Co., Fidelity Bldg., Buffalo. Estimated cost, $35,000. Electric traveling cranes will be installed in same.

N. J., Newark—The Board of Education will soon award the contract for the installation of heating, ventilating and electric systems in all public schools in the city.

N. J., South Amboy—The Board of Education has awarded the contract for the installation of a heating system in its proposed 3 story, 90 x 150 ft. school on John St., to the Johnston Heating Co., 131 East 26th St., New York City. Estimated cost, $10,500.

Ohio, Caledonia—City has awarded the contract for the construction of an electric transmission line from here to Marion, to Kelly & Pommert, Caledonia.

Ohio, Cleveland—The Board of Education has awarded the contract for the erection of a 3 story, brick and concrete shop, boiler and coal room addition to the school at 2486 East 46th St., to H. F. Juergens Co., East 49th St. and Gladstone Ave. Estimated cost, $79,300.

Ohio, Cleveland—The Steel Products Co., 2196 Clarkwood Ave., has awarded the contract for the erection of a 1 story, 45 x 70 ft. power house at 2188 East 65th St., to S. W. Emerson, 1900 Euclid Ave. Estimated cost, $17,000.

Wis., De Pere—The De Pere Manufacturing Co. has awarded the contract for the erection of a 100 x 100 ft. brick boiler shop, to A. J. Beauregard, De Pere. Estimated cost, $15,000. Equipment will be installed by the owner. Noted June 4.

Wis., Kenosha—The Simmons Manufacturing Co., Pearl St., has awarded the contract for the installation of a heating system in the proposed office building, to the Downey Heating and Supply Co., 613-5 Clybourn, Milwaukee.

Iowa, Clinton—The Climax Engineering Co., c/o C. B. Stebbins, foot of 4th St., has awarded the contract for the erection of a 1 story, 50 x 90 ft. power house, to Haring Bros., 402 Wilson Bldg.

Iowa, Fonda—The Fairburn State Bank has awarded the contract for alterations to a 2 story, 25 x 80 ft. bank, to A. Moorman & Co., 501 Minneapolis St., St. Paul, Minn. A low pressure steam heating plant will be installed in same.

Iowa, Pomeroy—The First National Bank has awarded the contract for the erection of a 1 story, 27 x 50 ft. bank building, to A. Moorman & Co., 501 Minneapolis St., St. Paul, Minn. A low pressure steam heating plant will be installed in same.

Mo., Carthage—The Board of Education will soon award the contract for the installation of ventilating plants in two ward schools. Plans include engines, motors, fans and heating coils. Estimated cost, $10,000. J. H. Felt & Co., 802 Grand Ave., Temple, Kansas City, Mo., Arch.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.35	$4.00
Barley	2.15	1.90	2.40	2.15
Buckwheat	3.15	2.90	3.75	3.80
Rice	2.65	2.40	2.65	3.40
Boiler	2.45	2.20	3.55	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.55-2.70
2-in. lump	2.55-2.90	2.55-2.70	2.55-2.70
Steam egg	.....	.....	2.20-2.40
Mine-run	.....	2.35-2.50	2.00-2.20
No. 1 nut	2.55-2.90	2.55-2.70	.....
2-in. screen	2.05-2.20	2.05-2.20	.....
No. 5 washed	2.05-2.20	2.05-2.20	.....

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$2.05	$2.35	$1.75
Pratt, Jagger	2.25	2.55	1.95
Corona	2.30	2.65	1.95
Black Creek, Cahaba	2.75	3.00	2.35

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.